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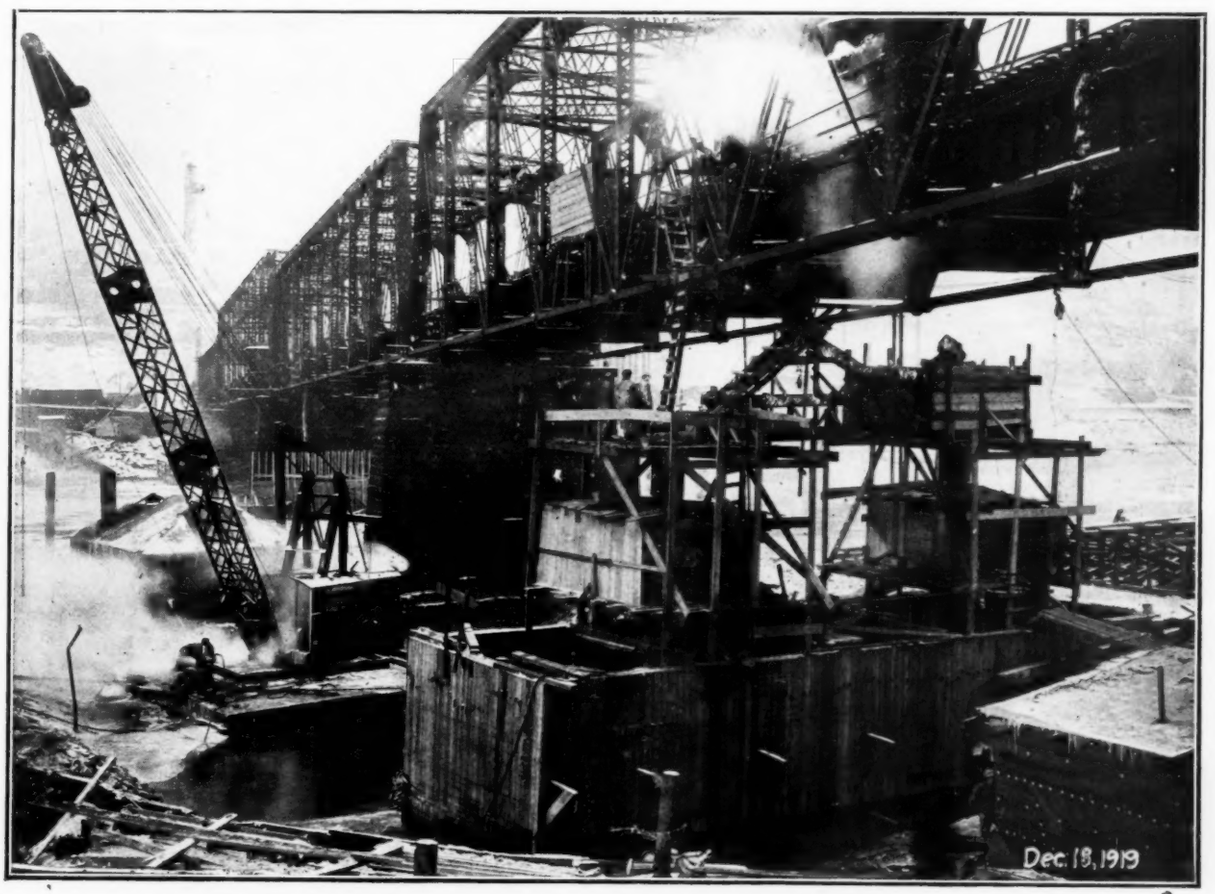

PNEUMATIC CAISSON PIER FOUNDATIONS CONSTRUCTED UNDER OLD SPANS

IN THIS ISSUE

Asphalt Paving in Tarboro
Concreting Plant and Operations
Designing Aqueduct of the Winnipeg Waterworks
Allegheny River Bridge Piers
Jointing Materials for Water Mains
Mathematical Analyses of Concrete Block Tunnels.

JULY 24, 1920

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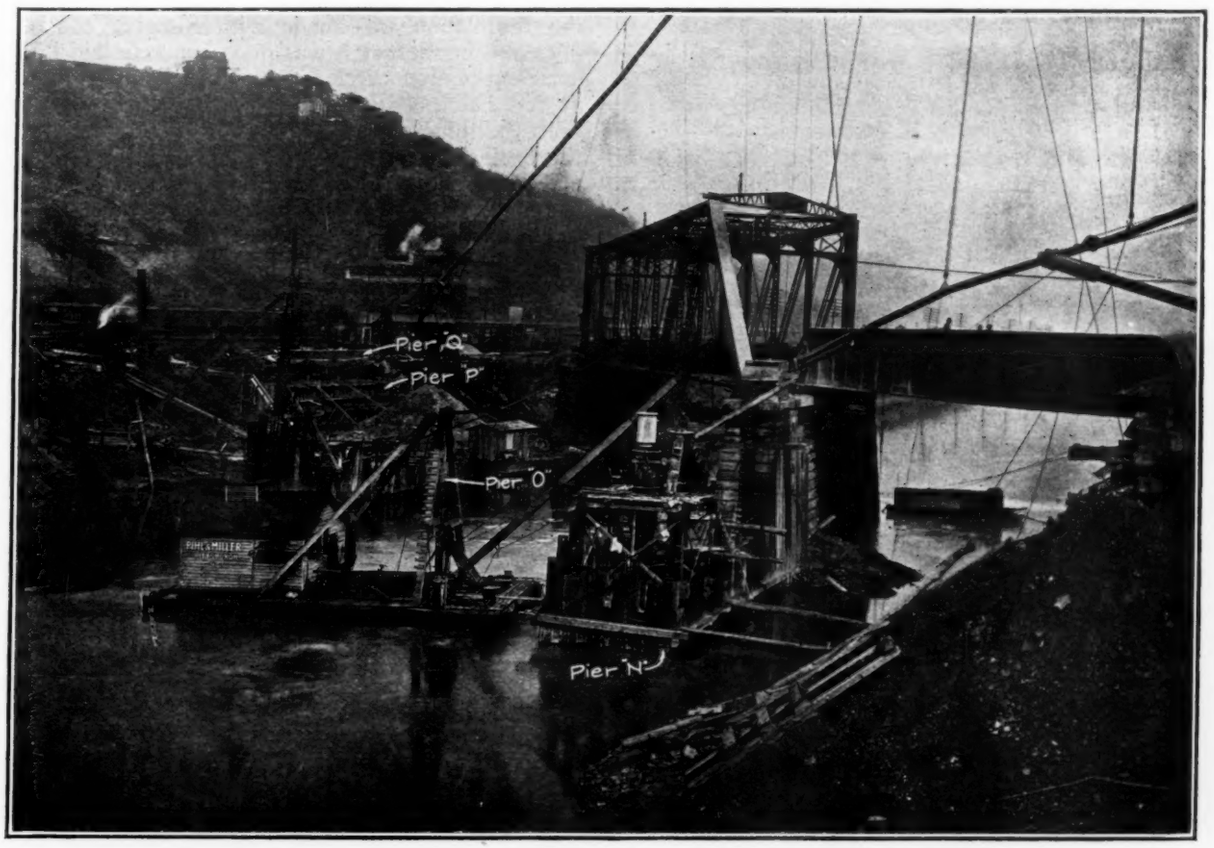
Vol. 49 FLORAL PARK, JULY 24, 1920 No. 4

Allegheny River Bridge Piers

Twenty piers and abutments for the Baltimore & Ohio railroad bridge across the Allegheny river and Herr's island, Pittsburgh, built with a variety of methods, including pneumatic caissons, cast-in-place concrete piles, open sheet-pile cofferdam and air bell. One pier supported on ancient submerged pile foundation was unexpectedly disclosed by the excavation.

At Pittsburgh a double-track line of the Baltimore & Ohio railroad crosses the main and back channels of the Allegheny river, and Herr's island that separates them, on a bridge with a tangent alingment across the main channel and a curved alignment across the island and back channel. In the reconstruction of the bridge a number of the piers under the tangent and adjacent to it were built on the old alignment, but clear of the superstructure and intermediate between the old piers. At a point on Herr's island, the old alignment diverges from the new one, the latter being carried, at the end of the bridge, on a pile trestle. The new piers under the curved alignment across the back channel of the river and on both sides of it, are parallel with the axis of the river and considerably skewed with the



SINKING RIVER PIER FOUNDATIONS BY PNEUMATIC CAISSON PROCESS

bridge alignment. Several of them join the old piers end to end.

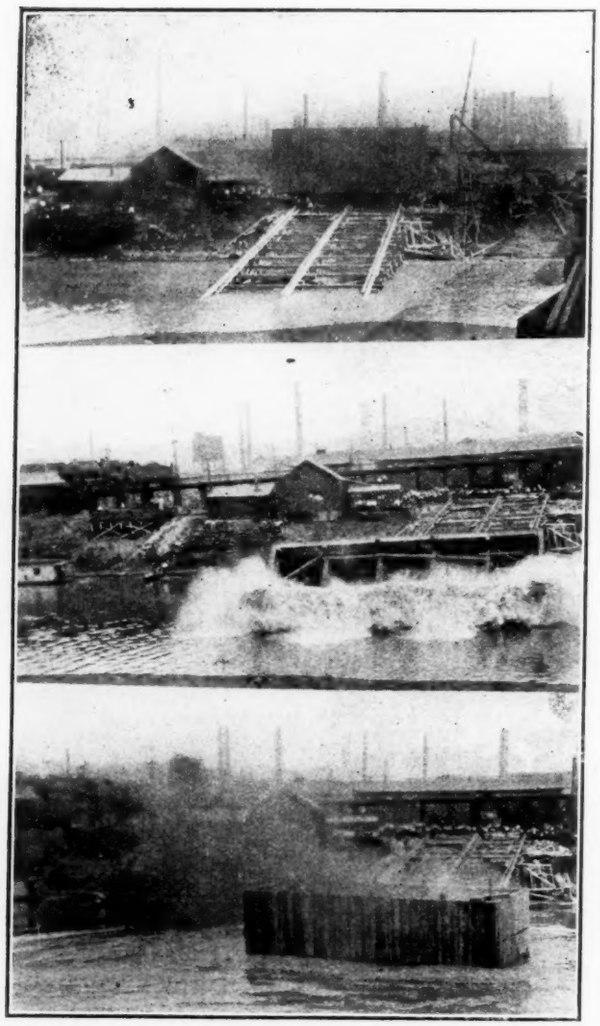
PLANT AND EQUIPMENT

The main part of the contractor's plant was installed on Herr's island, where there were erected a boiler house and air compressor shed, a concrete mixing plant with a steel hoisting tower 225 feet high, four stiffleg derricks commanding some of the piers and serving the concrete mixing plant, a contractor's siding approximately parallel to the bridge alignment, and a detour track temporarily carrying the railroad traffic clear of the new piers that were located partly on the old and partly on the new alignment.

The contractor also installed several stiffleg derricks on both banks of the river, installed a concrete spouting cable parallel to the alignment between the west end of the bridge and the hoisting tower, and at the east end of the bridge established a caisson building yard and launching ways for the construction of the wooden pneumatic caissons.

CAISSON FOUNDATION

At the east end of the bridge, three 70x72-foot caissons were sunk to a depth of about 60 feet to bearing on the bed rock. These caissons being located directly under the old spans, were somewhat cramped for headroom for the air locks and were served by floating derricks that handled the muck and the concrete.



BUILDING, LAUNCHING, AND FLOATING WOODEN PNEUMATIC CAISSON

Two other piers, those on the banks of the island, were built with wooden pneumatic caisson foundations but in these cases the caissons, instead of being constructed at the contractor's yard on the east bank of the river and floated to position, were built in *situ* and concreted with the same plant that was used for the main channel piers. Air pressure was put on the first of the five pneumatic caissons Sept. 18, 1919, and the last working chamber was concreted December 21st.

OLD PILE FOUNDATIONS UTILIZED

The pneumatic caisson pier on the east bank of Herr's island was intended to be sunk to rock about 48 feet below water level, but at a depth of 13 feet there was encountered a course of stone 28 inches thick on a timber grillage 28 inches thick supported by wooden piles 3 feet apart on centers. Although these piles had been driven about 40 years, they were found to be sound and in good condition. Excavation was carried down about 5 feet below their tops, and they were cut off and supported the concrete filling of the working chamber at a depth of about 22 feet below water level.

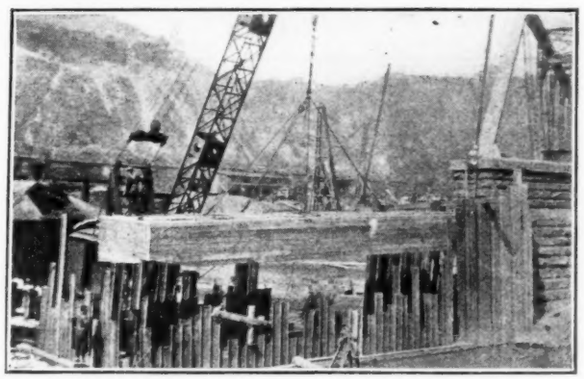
The west abutment and the six piers next to it were built on Simplex piles. The seven piers on Herr's island were built on foundation of Simplex concrete piles extending to above water level.

Two of the piers on the west side of Herr's island and the adjacent pier in the back channel were built in steel sheet-pile cofferdams. In one of these piers the foundation was made with Simplex concrete piles and in another it was mass concrete laid in an open excavation carried down to a depth of about 22 feet below water level.

In the third of these cofferdam piers (pier N. in the back channel, which was built adjacent to the end of the old pier), it was found impossible to unwater the cofferdam by ordinary methods, and a shallow airtight wooden caisson built of planks and fitted with airshafts and airlocks was installed in the cofferdam and concentric with it. This caisson, called an air bell, was sunk to bearing on the bottom of the river and the space between it and the cofferdam was sealed with concrete deposited by a tremie. After this concrete had set, the cofferdam was pumped out and concrete was built up to water level permanently enclosing the air bell, which thus formed a working chamber under the center of the pier.

After the light air bell had been throughly protected and strengthened by the mass of concrete above it, air pressure was put on, the water expelled, and men entered the bell, cleaned and benched the rock, and filled the bell, or working chamber with concrete, thus carrying the pier foundation down to solid rock about 20 feet below low-water level.

The work was done under the direction of the engineering department of the Baltimore & Ohio Railroad by the Vang Construction Company, Cumberland, Maryland. It was commenced in July, 1919, and has been completed as far as pos-



PLACING AIR WELL INSIDE FLOODED COFFERDAM

sible before the erection of the steel superstructure. After that is finished, the old river pier at the east end will be removed and replaced by a new one and the tops of the five new piers under the old structure will be finished and the old piers removed.

Special Rail Handling Method

Steel rails for the main lines of the Union Pacific Railroad in Nebraska were shipped in cattle cars during the winters of 1919-20, because of the impossibility of securing open top cars. The rails were unloaded through holes cut in the ends of the cars and were handled by special tongs or hooks engaging the bolt holes in the ends of the rail and attached to a hoist line operated by an American railroad ditcher machine mounted on a flat car that was separated from the rail car by an idler flat car. After a quantity of the rails had been removed from the stock car and placed on the floor of the idler car, the special hooks were replaced by regular rail tongs, and the rails unloaded from the flat car and put in position along the track in the usual manner manner. By this method an average of six carloads or about 450 rails were unloaded daily by one 10-man gang working between trains under difficult conditions of heavy main line traffic.

Asphalt Paving in Tarboro

By W. A. Hardenbergh

Labor saving appliances in asphalt pavement construction. The steam shovel is used as a wagon booster. Thickness of base adapted to traffic anticipated. Aggregate raised to mixer by bucket elevator, both electrically driven.

Located in the center of a very rich cotton, tobacco, and peanut section, the city of Tarboro, N. C., is one of those fortunate municipalities which finds itself able to initiate and carry out an extensive program of municipal improvements. In addition to a very complete local health organization, sewers are being extended and a paving program involving the laying of 80,000 square yards of asphalt pavement is under way. Of the paving work, about 50 per cent is now completed and the contractor, F. J. McGuire, of Norfolk, Va., is pushing the work rapidly.

There is some difficulty in securing an adequate supply of labor, but this is not a pressing problem. To as great an extent as possible, mechanical equipment is used. With mechanical equipment, good men are necessary. These are secured at rates of $3.50 to 4.50 per day. Most of these men are truck drivers, or semi-skilled in other ways.

Practically all the paving is of 2-course asphalt on a concrete base, with concrete curb and gutter cast in one piece. The only variation in the paving program, which covers the city pretty completely, is a specification requiring a thicker concrete base on those streets where it is expected traffic will ultimately become very heavy in wheel-load as well as volume.

About 500 yards of pavement are being placed daily by the contractor. Machinery and motor trucks are used whenever possible. Hauls are nearly all short, as the town is a compact area of five or six thousand population, but motor truck hauling has proved economical nevertheless. Throughout, the work shows careful planning and administration.

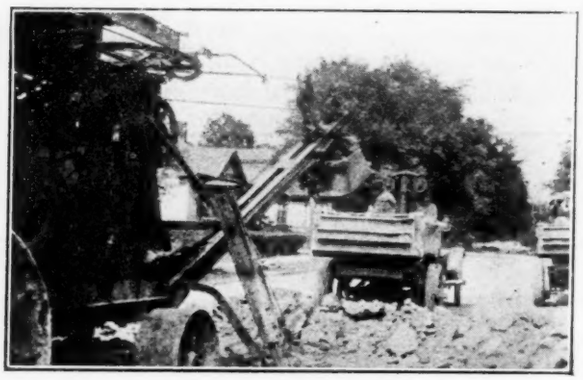
Considerable grading has been necessary, but this has practically all been very shallow. In fact, the bulk of it has not exceeded 8 inches in depth, the proposition being chiefly one of lowering the old street level enough to permit the construction of a concrete base and asphalt top. To handle this work, the contractor has used with considerable success two No. 6 Keystone shovels. The excavation is rather easy, as a rule, as the soil is mainly a sandy loam with practically no stones or hardpan to interfere.

Federal 2½-ton trucks have been used exclusively in the hauling and transportation, handling the spoil from the excavation, concrete aggregate, the concrete itself, and, finally, the hot asphalt.

By means of locating nearby places to dump or fill, hauls of spoil have been kept very short, and three trucks will more than handle the excavation of one shovel. The hauls rarely exceed a quarter of a mile.

Some of the streets were wide enough so that but

half the street width could be excavated at one time. In this case, the trucks usually backed alongside the shovel on the old pavement for filling, and so were favored with a good roadway. On narrower streets, and when excavating the final half of wide streets, it was found advisable to back the trucks, in a majority of cases, onto the subgrade, and just to one side of the shovel for easy filling. With the solid tires and the soft sub-grade, there was trouble at once, as the trucks usually sank down to the running gear, which resulted in delay, owing to the inability of the truck to pull out under its own power. This was remedied by "boosting" the truck out with the shovel. This method was completely successful and the shovel operator soon became very expert at it. But it was found that the pressure



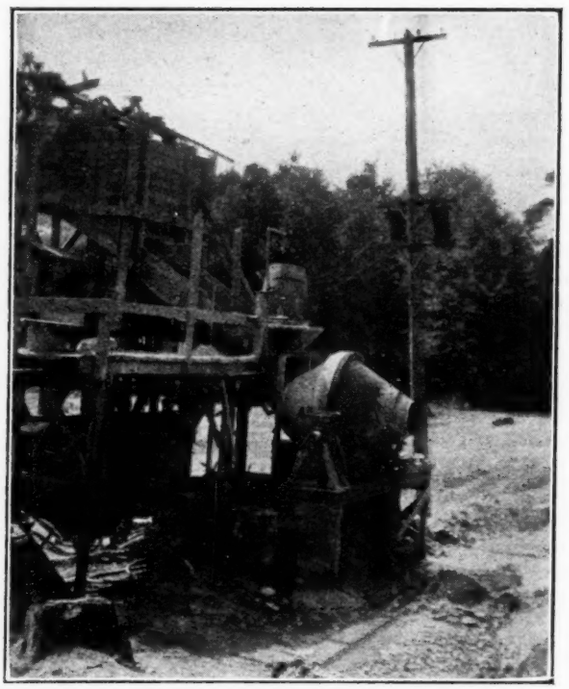
SHOWING BOOSTER BAR ON REAR OF TRUCK

KEYSTONE SHOVEL LOADING TRUCK

sprung the back door of the steel body. The superintendent, Mr. Johnston, then designed a "booster brace" of 4x4 timber, reinforced across the tail gate of the trucks. This device, which is shown in the illustrations, prevented any damage to the truck, and made the booster plan one of real value.

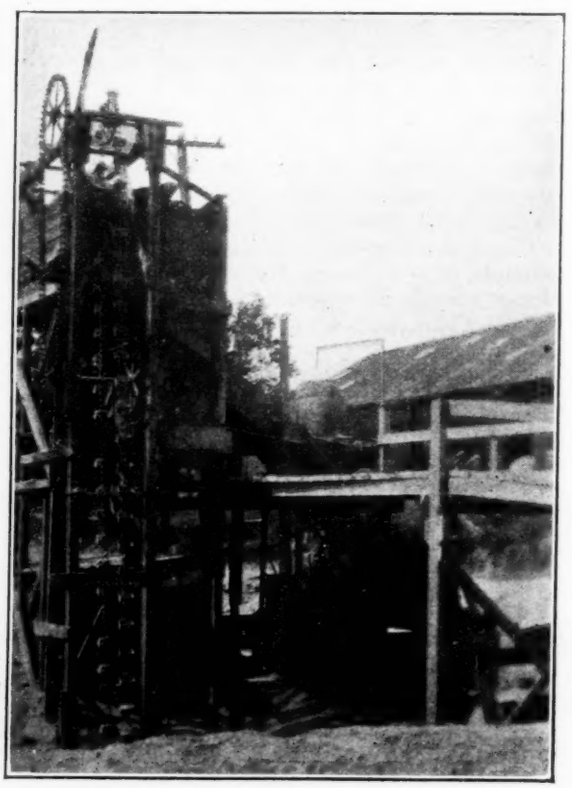
The power of the shovel when boosting was impressive. On several occasions when the driver had killed his engine by too quick an application of the clutch, the shovel pushed the loaded truck, the dirt of the subgrade scraping the running gear, clear out over the loose dirt which piles up ahead of the shovel, and onto the firm pavement, actually re-cranking the truck engine in the process. The shovel man soon became so expert at this that scarcely a moment was wasted.

Three men, only, were employed at the shovels—an operator, a fireman and helper combined, and a man to handle the rope for dumping the bucket.



THE MIXING PLANT

One man was on each truck. Every truck was equipped with mechanical dumping apparatus. One man was at the dump to direct the placing of the earth. With this equipment and personnel, the work proceeded very well.



ELEVATORS AT THE MIXING PLANT

Fine grading was done by horses and scoops or scrapers and by hand, the method and the number of men depending upon the work to be done, the particular street and the number of men available.

The pavement base was 1: 2: 4 concrete, 4 inches thick on most of the streets. On those streets where it seemed that the future might bring traffic of heavy wheel load, as those leading to the freight stations and along the railroad tracks, a 6-inch base was laid, using the same mix.

All concrete mixing was done at a central plant, and the wet concrete hauled in tight steel-body trucks to the streets, where it was spread as desired. A T. L. Smith mixer was mounted on a platform of such height that the mixer would dump readily into a truck beneath. Sand and stone were stored in overhead bins, and cement was brought from the cement shed over a runway. The entire outfit was operated electrically. Giant portland cement was used.

Stone and sand had to be shipped in by rail, and the cars were unloaded near the mixer. If the cars were equipped with dump bottoms, they were run onto a small trestle and dumped. Otherwise they were unloaded by men with shovels, the piles being as near as convenient to the mixer.

The sand and stone were raised to the overhead bins by means of Jeffery elevators, also electrically driven. The transfer of the aggregate from the piles where it had been unloaded, to the elevator buckets was not, as is usual, by means of a wheelbarrow gang. Two mules, each hitched to a slip scraper, did this at a considerable saving.

A stock pile of stone was stored on a vacant lot. When needed, a Keystone shovel loaded this direct into trucks, by which it was carried to the point of demand. This reserve was located at a central point for the paving work, and for the construction of a concrete culvert by the same firm.

As stated before, the mixer as well as the elevators is electrically driven. This is a considerable saving in cost, both from the power and the labor standpoint. With the arrangement described, of overhead bins for stone and sand, a nearby cement shed and electric drive, efficiency and economy were secured with a minimum of lost time and with few men.

The mixed concrete was dumped into the motor trucks and hauled at once to the street. As most of the hauls were very short and the mixture was kept rather dry, there was no trouble from separation of the aggregates, nor was it difficult to clean the bottom of the truck-body. This method of handling the concrete was very satisfactory and required only about half as many men as the usual method of mixing on the spot.

The asphalt pavement is laid in two courses, each an inch and a half thick. The binder course is being mixed with 10 1-3 per cent of asphaltic cement (Texaco), 54 to 56 pounds of filler and 500 pounds of stone. The wearing course contains approximately the same percentages, substituting sand for the stone.

A Cummer 800-yard plant is being used for making the mix. At times this plant has been operated to or beyond its full capacity, but at present the daily average is in the neighborhood of 500 square yards.

The same type of Federal 2½ ton truck, of which there are eight or ten on the job, is used for hauling the "hot stuff." The asphalt mixture is loaded direct into the truck in the usual fashion and hauled to the street. The average gang on laying is comprised of one rollerman, one finisher, three shovelers, and three rakers. A Kelly-Springfield roller is used for rolling the asphalt.

Throughout, the job shows evidence of good management and a careful use of machinery instead of men, whenever possible. No costs have been given on the work, nor are prices available at present.

Road Work in Illinois

On July 2nd, superintendent S. E. Bradt, of the Illinois Division of Highways, reported 57 road gangs at work completing 15 miles of hard road each week, and that he still has hope of completing the season's program of 450 miles of Federal Aid road, there being a prospect of raising the weekly total to 25 miles. However, the shortage of cars is threatening the program seriously.

Road Maintenance in Maine

Both patrol and gang method used. The method of giving a bituminous surface to gravel roads is described.

The following is from the report for the year 1919 of the State Highway Commission of Maine:

Maintenance work was continued as it has been carried on for the last three years, principally by the patrol method. In another part of this report will be found a detailed summary of that work. It will be noticed that the prevailing high costs of labor and material are reflected in the costs of this work as compared with similar costs in 1918.

Besides the patrol maintenance considerable work was done by gangs. This work is principally on improved state highways. We have a considerable mileage of gravel surfaced state highway which carries excessive motor vehicle traffic, official counts showing as high as 5,500 motor vehicles passing a given point in twelve hours time, from seven o'clock in the morning until seven in the evening, this count being a daily average for one week. A plain gravel surface would not last a week under this kind of travel, so it has become necessary to give these sections a bituminous surface treatment in order to preserve them. A good many inquiries have been received about our method of surface treating gravel roads, so a brief summary of the operation will be given here.

Surface treatment can only be successfully applied to a clean, well bonded surface having a true cross section. The first step is the distribution of clean, coarse and sharp sand along the shoulder

of the road in piles about thirty feet apart, using about forty to fifty cubic yards per mile. This sand is used to cover the bituminous material after it has been spread upon the road.

The next step is to thoroughly clean the surface with a horse sweeper and hand brooms, in this way removing all dust and loose material. The bituminous material is then spread from a pressure distributor tank mounted either on an automobile truck chassis or drawn by horses. The amount of bituminous material per square yard of surface depends on the condition of the surface and as a general thing good results will not be obtained by making a uniform distribution over the whole area, because it is very rare that any considerable area will present exactly uniform conditions. This means in practice that more or less material per square yard must be used according to the condition of the surface. In our practice the amount of bituminous material is controlled entirely by the judgment of the man in charge of the work. He rides on the truck and from his knowledge of the conditions determines the amount of pressure to be applied to the tank, the opening of the valves that control the flow of tar, and the speed of the truck. On new surfaces the rate of distribution will vary from four-tenths of a gallon to one-half a gallon per square yard. The second, third or fourth years, the application may be as light as one-quarter of a gallon per square yard and usually is from three-tenths to one-third of a gallon..

This work must be done on a warm day and on a dry surface. If traffic conditions would permit we would allow the bituminous material to penetrate the surface six hours before covering with sand, but we find it necessary to immediately cover with sand from the piles alongside the road to keep the bituminous material from stripping up under steel tire traffic. Furthermore, there is great liability of automobiles skidding on the fresh bituminous material, and this is another reason for immediately covering with sand. About one-half the sand is immediately applied and during the next three or four days a few men are left behind to sand spots which show an excess of bituminous material as they appear. This means going over the same length of road several times. It is very important that the smallest possible amount of bituminous materials be used that will preserve the surface.

Except where drainage and foundation conditions are absolutely perfect this bituminous surface treatment will break up the following spring. It is very necessary where the breaking up occurs that the surface be reshaped by using the road machine and the drag. The surface must be kept in shape until it is settled and bonded, when another application can be made following substantially the steps outlined above, but using less bituminous material.

After three or four successive annual applications certain portions of the surface will become wavy. It is then necessary to break the surface by the use of a pressure scarifier or spike-tooth harrow. It is sometimes necessary to plow short sections and for this the point of a road machine blade may be used. After this course has been broken up it must then be pulverized. This may be done with a spike-tooth harrow or a steam roller with the picks. It also pulverizes more or less under travel. The pulverizing process can be hastened by working the material from one side of the road to the other with a road machine, letting travel break it up as much as possible. It is usually necessary to use a road machine every day from the time the surface is broken until the road is bonded for treatment. The more this material is worked over the more completely it will pulverize and a better surface will be presented for subsequent treatment. Immediately prior to the next treatment the surface must be carefully shaped. It may be necessary at this time to add a little binding material, preferably clay, but care should be taken not to use an excess of clay. Our practice has indicated that a quantity of fine pulverized clay (pulverized by frost action) about equal to the amount of sand cover, forty to fifty yards per mile, has given excellent results in preparing an old surface for re-treatment. The re-treatment of this surface after being broken is exactly identical with the original treatment, beginning with the sweeping. During the spring of 1919 a considerable mileage of road was broken up and re-treated as above rescribed, with very excellent results.

Street Repairing in Waltham, Mass.

The *Waltham Municipal Bulletin*, issued monthly, is a little different from most municipal publications. It reads something like a newspaper reporter's description of a ball game but gives real information concerning municipal affairs that should interest the public—a combination that should get it read by the citizens, which is what such a publication should aim at. The following is a sample of manner of presenting the more substantial information:

"The Street Division of the Public Works Department is putting forth every ounce of energy and working from every possible angle on the streets of our city, trying to get them in passable shape.

"Waltham, like all other cities and towns, was forced to curb its street construction and maintenance during the time Bill took the notion to run the world and the result is our streets are completely shot.

"We feel that some of our good citizens are unreasonable enough to expect us to rebuild in two months that which has been neglected for four years. This, of course, is impossible, but we are sure if our citizens will co-operate and be patient, the end of the construction season will show a big change for the betterment of Waltham's streets.

"Besides carrying on all the necessary incidental work of the department, over 200,000 square yards of street have been patched and oiled during the last three weeks. Many streets have been resurfaced with material excavated from streets being constructed of bituminous macadam and will receive a coat of oil in the near future. A few days will see the completion of River street, one

of the many streets to be constructed under the $100,000 bond issue. The construction of River street consisted of reshaping the old macadam base by excavating from 3 to 4 inches of the old material. After this base had been throughly rolled, 3 inches of new stone, 2 inches in size, was spread evenly on it, and after being rolled an application of Tarvia X at the rate of 1½ gallons to the square yard was applied. Chestnut stone was then spread over the surface, just enough being used to fill the voids, and the whole road again thoroughly rolled. The surface was then sealed with ¾ gallons of Bermudez asphalt to the square yard, covered with pea stone, rolled, and opened to traffic.

"The following table shows the cost of River street and what it would cost six years ago. It might be of some interest to know that the best bid received on the above type of road was $2.00 per square yard, a saving of 60c per yard; or, on the 25,000 yards advertised on Lexington and High streets, the city will save $15,000."

Table showing cost of 2,980 square yards of bituminous macadam pavement on River street:

Labor 389 hours at .48	$186.72
Labor 1652 hours at .52	859.04
Labor 359½ hours at .56	201.32
Labor 175 5-6 hours at .625	109.99
Labor 116 hours at .688	79.76
Labor 10 hours at .812	8.12
Misc. and Sat. half holidays	122.57
Teams 55½ days, 4.75	263.63
Teams 5½ days, 2.25	12.38
Trucks 15 days, $12	180
Trucks 1½ days, $20	30
Rollers 14½ days, $6	87
Stone	922
Tarvia 4,280 gals. at .14	599.20
Asphalt 2,000 gals. at .24	480.
Coal	77.24
Total	$4,219.07

Per square yard, $1.41.

What River Street would have cost under 1914 prices:

2,041 hours at .275	$516.28
359½ hours at .306	110.01
175 5-6 hours at .375	65.24
116 hrs. at .344	39.90
10 hours at 50	5.00
Saturday half holiday	61.00
Teams 74 days at 3.00	222.00
Teams 5½ days at $1.50	82.50
Roller 14½ days at 1.75	25.28
Stone	310.00
Tarvia 4,280 gals. at 8¾c	374.50
Asphalt 2,000 gals. at 12c	240.00
Coal	25.00
Total	$2,122.41

Per square yard, $.71.

Municipal Ownership of Electric Railways

The restoration of credit is the principal task of the electric railways, according to John H. Pardee, president of the American Electric Railway Association. Investors demand a fair return on money invested in traction securities.

In 1917 the electric railways carried 11,000,000,000 passengers, an average of 108 rides for every man, woman and child in the country. This number was 2,000,000,000 greater than in 1912, and 4,000,000,000 greater than 1907. While the population of the country has increased 32 per cent the passenger traffic of electric railways has increased 137 per cent.

An examination of the report of municipally owned electric railways, according to Mr. Pardee, shows that municipal ownership is not the solution. Two of eight roads reported on included in their financial statements no charge because of interest on funded or unfunded debt, only three reported taxes, and two had tax charges which were pittances compared with the tax bills of privately owned companies. In spite of these favorable missions, the eight lines show a deficit for the year of $141,000, out of total operating revenues of $1,682,000, while the ninth road, not included in the total, had a deficit of operating expenses.

Road Making in Edmunds County S. D.

By WARD L. McCAFFERTY*

How the county forces make good gravel roads, even on gumbo soil.

There is in Edmunds County, South Dakota, some low, flat land and some that is very rough, but most of it is gently rolling. The roads generally follow the section lines, with an occasional short one intermediate. There is a state and federal highway running east and west near the center of the county, and seven county highways running north and south. Sixteen miles of state and federal aid highway is now under construction.

In constructing a county road we start out with an outfit called our blade grader crew, consisting of one Twin City 60-90 tractor pulling a 12-foot blade grader and one 90-120 Holt tractor pulling a 14-foot blade grader. This crew is fitted out with a complete outfit consisting of cook car and tents for sleeping quarters. We work both ways from camp, as a rule three miles each way. After the blade has made a round, it is followed up with a planer which brings the dirt in from both sides of the road to the center with one operation. After this has passed down the road, another blade grader follows it so that it can come back and do the same work pulling in the dirt with one operation. About three rounds with a blade grader with the planer following will make a complete graded road on level ground.

After we have passed over a section of road in this manner, we follow up with a crew to make fills in such places as require more dirt to bring the low places above high water. At the same time such culverts as are required to take care of the water in spring and after heavy rains are placed in the grades or fills as we go along. This completes a road known as a dirt road.

After these have been traveled a short time they are in condition for graveling. We maintain all these graded roads with such machinery as small engines for power and we have drags of several different makes. The three-way drag is about the

*Superintendent of highways of Edmunds County.

best of this equipment. This is a three-section drag, the two outside drags bringing the loose dirt in towards the center of the road and the center drag distributing it evenly over the center of the highway and filling up the ruts in the road, if any have been produced during the rains by heavy traffic. I will say in passing that just dirt roads are not all-season roads, but they are good in summer and fall and most winters. Gravel surfacing will be done as rapidly as our funds will permit. In South Dakota our Motor Vehicle Fund (that is, license money from automobiles collected by the county treasurer) is placed at our disposal and can be used for dragging and all other maintenance work and for graveling roads, but for no other purpose; in other words, all equipment for this work must be provided from other funds.

Our top soil is a deep, black loam, from 6 to 18 inches deep, under which is a clay subsoil. This subsoil, when worked into a road and covered with gravel, makes an ideal roadbed. In some parts of the county we have the gumbo soil. A great many held up their hands in horror when we started grading roads through the gumbo—they declared this would be our finish and that we could never make a road out of the gumbo soil, but experience has taught us that gumbo, if it is properly drained and maintained, is the best road soil we have and much better after being graveled than any other soil that we have here.

We hire and pay our crews by the hour—no work no pay. The cook car is furnished and as a rule is run by a man and wife, the husband working on the job and the wife doing the cooking, charging each one of the crew a certain price for their board, with no expense to the county, we simply furnishing the car and some minor equipment for the same.

We hire men and teams for dirt moving or making the fills by the yard. All our roads are surveyed and in this way we can easily follow the outfit making the fills and determine the exact amount of dirt moved and placed in the fills. We settle with them twice a month, holding back 15 per cent of the estimate until final settlement on the work for our protection.

We make a special effort and take great pride in keeping all our roads passable immediately following the crews and also while they are working. It is very seldom necessary to make detours on any roads that we are working.

Ring Analysis - Granular Material - 13° Angle of Repose.

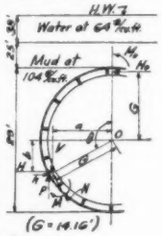
This analysis assumes that Hudson River silt is a perfectly granular semi-fluid without cohesion and conforming to the theory developed by Rankine, Coulomb, and Howe as to the amount of active horizontal pressure and active upward pressure at any point in the material.

If v = wt. of material above any point, per sq. ft
h = unit pressure horizontally, p = unit pressure upward.
Then for 13° material, $h = v \tan^2(45° - 6°30') = 0.634\,v$, and
$p = Kv$, in which K must be greater than (0.634)² and so determined that wt. of tunnel and material is equal to total upward force on lower half of tunnel.

Applying first to the 29'-0" outside diameter cast iron, during construction and before concreting: Wt. of one foot of tunnel = 13560.*
As shown on Sheet No. 6, Case III, $K = 0.754$

At $\theta = 0$,	$v = 5032$,	$h = 3190$,	$p =$ ———
$\frac{\pi}{4}$	6540	4146	4931
π	(8048)	5102	6068

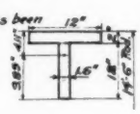
It will readily be seen that at a point determined by angle θ,
$v = 6540 - 1508\cos\theta$, $h = 4146 - 956\cos\theta$, $p = 4931 - 1137\cos\theta$.



Let V = total vertical force at this section determined by angle θ,
N = total normal force, M = moment around c.g. of section
H = component of horizontal force due to earth pressure (zero at $\theta = 0$)
G = dist. to c.g. of section, H_0, M_0 = thrust, moment at top.
Then due to wt. of ring alone, force = 2158θ, mom. about $O = 30557\,(1-\cos\theta)$
At any point $H = \int_0^\theta (4146 - 956\cos\theta)\,14.5\sin\theta\,d\theta = 60117\,(1-\cos\theta) - 6931\sin^2\theta$.
$bH = \int_0^\theta 14.5\cos\theta\,(4146 - 956\cos\theta)\,14.5\sin\theta\,d\theta = 435848\sin^2\theta - 67000\,(1-\cos^3\theta)$.
In upper half $V = 2158\theta + \int_0^\theta (6540 - 1508\cos\theta)\,14.5\cos\theta\,d\theta = 94830\sin\theta - 8775\theta - 10933\sin\theta\cos\theta$
$aV = 30557\,(1-\cos\theta) + \int_0^\theta 14.5\sin\theta\,(6540 - 1508\cos\theta)\,14.5\cos\theta\,d\theta$
$= 30557\,(1-\cos\theta) + 687520\sin^2\theta - 105686\,(1-\cos^3\theta)$
In lower half $V = 2158\theta + 19103 + \int_0^\theta (4931 - 1137\cos\theta)\,14.5\cos\theta\,d\theta$
$= 2158\theta + 19103 + 71502\sin\theta - 8243\theta - 8243\sin\theta\cos\theta$.
$aV = 30557\,(1-\cos\theta) + 143130 + \int_0^\theta 14.5\sin\theta\,(4931 - 1137\cos\theta)\,14.5\cos\theta\,d\theta$
$= 30557\,(1-\cos\theta) + 143130 + 518398\sin^2\theta - 79687\,(1-\cos^3\theta)$.
Now let M_1, N_1 be moment and thrust for $\theta = \frac{\pi}{2}$, M_2, H_2 for $\theta = \pi$.
At once $N_1 = V = 81046$ and $H_2 = 29 \cdot 4146 - H_0 = 120234 - H_0$ (Symmetry considered.)
Then $M_1 = M_0 + 14.16\,H_0 - 904068$, and $M_2 = M_0 + 28.32\,H_0 - 1523643$.
(Above obtained by substitution in $M_0 + GH_0 + aV = M + GN + bH$.)

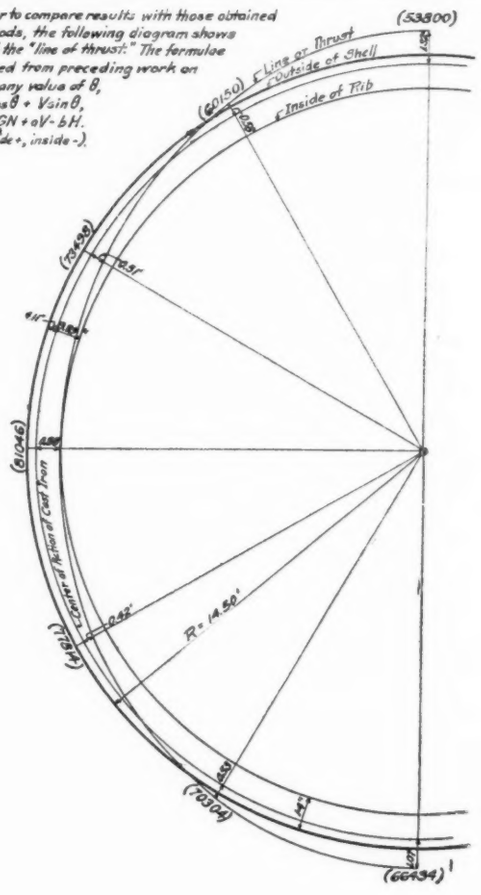
In an arch ring with constant section it is a very close approximation to an exact use of the Method of Least Work to give such values to the redundants that the sum of the squares of moments taken at equal intervals around the arch ring is a minimum. In this particular case the intervals may be quarter-circumferences without lessening precision. Applying this criterion, $(M_0^2 + 2M_1^2 + M_2^2)$ must be a minimum for the deduced values of M_0 and H_0, thus giving the equations $M_0 = -M_1 = M_2$.
Solving, $H_0 = 53800$ (lbs.), $H_2 = 66434$ (lbs.), $M_0 = -M_1 = M_2 = 71123$ (lb.-ft.)

In computing strength of section, the equivalent section shown has been assumed. For this section $R = 43.2''$, $I = 761$ in.⁴, c.g. is as shown
Using the formula $f = \frac{M}{R} \pm \frac{12Mc}{I}$ (compr. +, tension -)



	Outside	Inside
$\theta = 0$	+5854 #/□"	-9846 #/□" (max. tension)
$\frac{\pi}{2}$ (90°)	-2833	+12967 (max. compression)
π (180°)	+6147	-9553

In order to compare results with those obtained by other methods, the following diagram shows the position of the "line of thrust." The formulae used are derived from preceding work on this sheet. For any value of θ,
$N = (H_0 - H)\cos\theta + V\sin\theta$,
$M = M_0 + GH_0 - GN + aV - bH$.
$Ecc. = \frac{M}{N}$ (outside +, inside -).



Computations
Vehicular Tunnel
Made by M. G. Findley
March 26, 1920

CALCULATION OF STRENGTH OF CYLINDRICAL CAST IRON SHELL OF SUBAQUEOUS TUNNEL 29 FEET DIAMETER

Mathematical Analyses of Concrete Block Tunnels

Ring analyses as applied to different types of tunnels proposed for vehicular crossing of the North River.

On page 549 of *Public Works* June 19 there was published an article entitled "Concrete Block Vehicular Tunnel Investigation." This article quoted at length from General Goethals' report to the Joint State Bridge and Tunnel Commissions dated April 2, 1920, on the theory of stress analysis of subaqueous tunnels and the structural strengths of cast iron and concrete block ring tunnels based on such theories.

The mathematical‡ analyses* accompanying the Generals' report included:

A. 29 foot outside diameter cast iron tunnel, based on Rankin's theory for granular material.

B. Derivation of general formular based on theory of analyses for pressures normal to tunnel.

C. Results of application of normal pressure theory to four cases, namely:

1. 42 foot outside diameter concrete block tunnel;
2. 36½ foot outside diameter concrete block tunnel;
3. 29 foot outside diameter cast iron tunnel;
4. 23 foot outside diameter Pennsylvania Railway tunnels under North River.

D. Computations for possibility of flotation of above types of tunnels, assuming perfectly granlar semi-fluid conditions with no cohesion.

E. Comparative longitudinal strengths of above tunnels.

* These mathematical studies were made by M. G. Findley, assistant designing engineer.

‡ Note that the differential sign where used in the formulae is distinguished from small "d" by having the bottom of the vertical stem connected to the symbol immediately following.

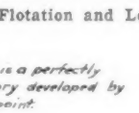
Calculations Concerning Flotation and Longtitudinal Strength and Theory of Ring Analysis.

Data as to Possibility of Flotation.

This computation assumes that Hudson River silt is a perfectly granular semi-fluid without cohesion conforming to the theory developed by M.A. Howe as to the amount of active upward pressure at any point:

If v = wt of material above any given point, per sq. ft
p = active upward pressure, in lbs. per sq. ft.
θ = angle of repose of material at given point
Then p = Kv, in which K = tan² (45° - ½θ)

Case I. Concrete block tunnel, 42'-0" outside diameter.



The forces acting downward and crossing the lower outside semi-circumference, for 1'-0" length of tunnel, are
42 (38·64 + 46·104) - ½π·21²·104 + π(21²-18²)150
= 286165.

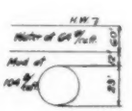
If mud were perfect fluid active upward pressure on this surface would be
42 (38·64 + 46·104) + ½π·21²·104 = 375115.

Thus structure will rise due unbalanced force if K is greater than 286165/375115 = 0.763. *Corresponding angle of repose θ = 3°52'.*

Case II. Concrete block, 36'-6" o.d.
36.5(38·64 + 43.25·104) - ½π·18.25²·104 + π(18.25²-15.25²)150 = 245865
36.5(38·64 + 43.25·104) + ½π·18.25²·104 = 307385.
For critical angle of repose, K = 245865/307385 = 0.800. θ = 3°12'.

Case III. Cast iron, 29'-0" o.d.
Wt of c.i. alone, before concrete is placed, is 13560# per lin. ft.
29(38·64 + 39.5·104) - ½π·14.5²·104 + 13560 = 168874.
29(38·64 + 39.5·104) + ½π·14.5²·104 = 224000
For critical angle of repose, K = 168874/224000 = 0.754. θ = 4°00'

Case IV. Pa. tubes, cast iron, 23'-0" o.d.



Wt. of c.i. alone is 9650# per lin. ft.
23(60·64 + 23.5·104) - ½π·11.5²·104 + 9650 = 132577
23(60·64 + 23.5·104) + ½π·11.5²·104 = 166137.
For critical angle of repose, K = 132577/166137 = 0.798. θ = 3°14'.

Summarizing the above results:

(a) The 29'-0" c.i. tunnel is most liable to rise.

(b) All four will rise in 3° material. As the Pa. tubes have not shown any tendency to rise, there is doubt as to cogency of this conclusion.

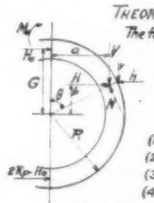
Comparative Longitudinal Strength.

Block tunnel 42'-0" o.d. - 160 bolts 1¾" diam. - bolt circle ave. 39'-0" diam.
Cast iron 29'-0" o.d. - 85 bolts 1¾" diam. - bolt circle approx. 28'-0" diam.
Pa tubes - 67 bolts 1½" diam. - bolt circle approx. 22'-0" diam.

From this information is obtained the following table of safe loadings:
(forces in kips, moments in kip-feet.)

	Block 42'-0"	C.I. 29'-0"	% of 42'-0"	C.I. 23'-0"	% of 42'-0"
Tension	6240	3264	52.3%	1890	30.3%
Moment	60840	22848	37.5%	10395	17.1%

Theory of Ring Analysis for Normal Pressures.



The following computation is based on a method of construction whereby gravel packing is tightly wedged between outside circumference of tunnel and inside of opening left by shield as it moves forward, creating initial normal pressures, which are later modified by the entrance of water into the voids of the packing. The four assumptions, based on observed phenomena and fundamental principles of mechanics, are as follows:

(1.) Unit pressure at top of ring equal to weight of material above.

(2.) Vertical and horizontal forces in equilibrium.

(3.) All pressures normal to surface of tunnel.

(4.) Pressures increase a uniform amount for each added foot of depth.

Let p-d = wt per sq. ft. of material above top of tunnel = normal pressure at top.
p+d = normal pressure at bottom. W = wt. of one foot of tunnel.
R = outside radius of tunnel, in ft.
Then to obtain equilibrium $W = \pi R d$. *(This equation determines d, and indirectly, p.)*
By symmetry, shear at top is zero.
Let G = dist. to c.g. of tunnel section, A = area of tunnel section per linear foot.
H_o *= thrust at top,* M_o *= moment at top, v, h = vertical, horizontal comp. of normal pressure*
V, H, N = vertical, horizontal, normal forces at section determined by angle θ.
v = h = p - d cos θ, acting on elements $R\,d\theta \cos\theta$ *and* $R\,d\theta \sin\theta$ *respectively.*
Comp. of V due to wt. of t. nel is $\frac{1}{2}GRd\theta$ *and mom. about ℄ is approx.* $\frac{1}{2}GRd\,(1-\cos\theta)$.

$$\text{Then } V = \tfrac{1}{2}Rd\theta + \int_0^\theta (p - d\cos\theta)R\cos\theta\,d\theta = Rp\sin\theta - \tfrac{1}{2}Rd\sin\theta\cos\theta.$$

$$aV = \tfrac{1}{2}GRd\,(1-\cos\theta) + \int_0^\theta R\sin\theta\,(p - d\cos\theta)R\cos\theta\,d\theta$$
$$= \tfrac{1}{2}GRd\,(1-\cos\theta) + \tfrac{1}{2}R^2p\sin^2\theta - \tfrac{1}{2}R^2d\,(1-\cos^2\theta).$$

$$\text{Also } H = H_o - \int_0^\theta (p - d\cos\theta)R\sin\theta\,d\theta = H_o - Rp\,(1-\cos\theta) + \tfrac{1}{2}Rd\sin^2\theta.$$

$$bH = GH_o - \int_0^\theta R\cos\theta\,(p - d\cos\theta)R\sin\theta\,d\theta = GH_o - \tfrac{1}{2}R^2p\sin^2\theta + \tfrac{1}{2}R^2d\,(1-\cos^2\theta).$$

$$\text{Now } N = V\sin\theta + H\cos\theta = H_o\cos\theta + Rp\,(1-\cos\theta).$$

Also mom. of N about ℄ $= M_o + aV + bH = M_o + GH_o + \tfrac{1}{2}GRd\,(1-\cos\theta)$.

Applying the Theory of Least Work, we observe that:

(1.) Work done by thrust is constant, and may be neglected without error.

(2.) If values of H_o *and* M_o *may be discovered which place N at c.g. of section at any point, work done by moment and shear is zero, and therefore a minimum. Such values may be found, and are* $M_o = 0$, $H_o = R\,(p - \frac{1}{2}d)$; *for substituting these values, we obtain* $N = Rp - \frac{1}{2}Rd\cos\theta$, *and mom. of* $N = GRp - \frac{1}{2}GRd\cos\theta = GN$.

These values are correct by the most rigid theoretical analysis. Max. value of N is at bottom, where unit compression $f = \frac{P}{A}(p + \frac{1}{2}d)$.

Applying this analysis, we obtain the following table.

Case.	W(#/lin. ft)	R (ft)	d(#/cu.ft)	p-d(#/cu.ft)	p(#/cu.ft)	A (sq.in.)	f #/sq.in.
I.	55135	21.00	836	5032	5868	432.0	305
II.	47360	18.25	828	5032	5860	432.0	265
III.	13560	14.50	298	5032	5330	43.2	1840
IV.	9650	11.50	267	5088	5355	38.4	1645

Pressure diagrams taken in the Pa. tubes conform very closely to this reasoning. Concrete lining increases weight of tubes. Results compare thus:

Observed		11.50	432		5760	38.4	1790
Computed	20000	11.50	553	5088	5640	38.4	1770

Computations.
Vehicular Tunnel.
Made by M.G. Findley, March 24, 1920.

Most of these analyses are given on pages 74 and 75, being photographed from the original prepared for General Goethals by M. G. Findley. The general principles and conclusions would seem to be equally applicable to sewers and other conduits of similar construction.

Jointing Materials for Water Mains*

Fred O. Stevens†

Expenses of water departments in Weymouth, Berlin, N. H., St. Louis, Boston and Atlantic City in the use of "Leadite," Lead hydrotite and similar materials.

The great difference in cost between lead and the non-lead joint materials makes it an obligation on the part of water-works engineers and executives to satisfy themselves as to the efficiency of the non-lead products. Although these materials have been in the market for about sixteen years, and have been used in increasing quantities during that period, they are still regarded by the great majority of water-works men with more or less skepticism.

The facts of the case are that lead has proved to be such an excellent material for joints, and workmen have become so well trained in its use, that engineers and superintendents have naturally and rightly hesitated to substitute for it a substance with which they are unfamiliar, and upon which there is a relatively small amount of data as to its efficiency.

The writer has used the two substitutes known as "Leadite" and "Lead-Hydro-Tite" for over eight years, in various localities and under varying conditions, with very satisfactory results, and as a consequence has acquired a great degree of confidence in them. The water-works profession, however, must be, from the very nature of its work, very conservative in adopting untried methods and materials, and is bound to demand something more than the testimony of a few of its members that a certain thing "works all right, as far as they know."

The purpose of this short review, then, is not to take a partisan stand in favor of any joint material, but to impress upon the members of the Association the fact that these substitutes for lead are worthy of careful consideration and investigation in view of the present prices of lead and labor. It is to be hoped that a general discussion may bring out some new facts and stimulate further investigations.

To the manufacturers the writer would suggest that, having now established the compartively low cost of their products in the minds of the water-works trade, they devote more energy to experimental work, to enable them to answer with definite figures the questions to which a thorough and thoughtful water-works man must have an answer before making what would otherwise appear to him a hazardous change.

The most important of these questions are as follows:

(1) How do joints of these materials compare with those of lead as to tightness under normal conditions?

(2) What of the possibility of blown joints

(3) Will the joint have sufficient strength to resist stresses due to bending moment when support is removed from a considerable length of pipe as a result of settlement of back-fill or nearby excavations for services etc.?

On the first question the writer is able to submit evidence derived from actual experiment. In the summer of 1917 the Weymouth Water Works laid 3,400 ft. of 8-in. pipe, from which no services were taken until the following season. The joints were of Lead-Hydro-Tite, and the new gate controlling this line was by-passed with a ⅝-in. Empire meter testing 99 per cent. in 1-32-in. opening. For the final measurements the flow was too small for accurate measurement by meter and a force pump was used, pumping from a pail into which water was fed by a standard gallon measure. The results as to leakage per linear foot of joint are shown in the following table, and would, according to available data on the subject, be considered excellent for lead joints.

Tests for Leakage from Lead-Hydro-Tite Joints, Idlewell Extension, North Weymouth, Mass.

Date	Section	No. of Joints	Gals. per Minute	Gals. per 24 Hrs. per Lin. Ft. of Joint	
1917.					
July 26	1	75	3.375	26.20	New Joints.
*Aug. 8	1	75	.150	1.16	
Aug. 20	2	180	.322	1.04	Sec. 1 plus 105 new joints.
Aug. 25	2	180	.305	.99	
Sept. 29	2	180	.217	.70	
Nov. 2	1	75	.041	.32	
Nov. 2	2	180	.098	.32	
Nov. 2	3	250	.495	1.15	Sec. 2 plus 70 new joints.
Nov. 2	4	335	3.500	6.16	Sec. 3 plus 85 new joints or entire extension.
1918.					
*June 1	4	335	.150	.26	

Pipe was 8-in. Class E., New England weights. Average pressure, 70 lbs.

Leakage measured by ⅝-in. Empire meter, registering 99 per cent. on 1-32 in. opening at 70-lb. gauge pressure.

*By pump and gallon measure.

This work was done by a man having one season's experience with Leadite, exercising the ordinary degree of care usually required by the writer on this class of work, and the results should give a fair indication of the degree of tightness to be expected under average conditions.

As to the matter of joints blowing out, the writer can only say that he has never known of a Leadite or Hydro-Tite joint blowing out. In fact the strength of these materials and their adhesion to the metal as demonstrated when a joint is dug out seems to be sufficient evidence of their safety in this direction without extensive experiment.

As to the behavior of this type of joint when subject to crushing stresses such as occur when

†Engineer and Superintendent of Water Works, Weymouth, Mass.
*Paper before the New England Water Works Association.

portions of a pipe line are left unsupported by the settlement of backfilling, the writer has been, until very recently, in doubt; in fact, uncertainty on this one point has prevented him from giving these materials his unqualified endorsement as substitutes for lead. This doubt has been pretty much dispelled by the results in a case that has recently come to his attention.

The Berlin Water Company of Berlin, N. H., built last year a new dam from which an 18-in. cast-iron main was to lead to the city distribution system. About two lengths of this pipe were in the dam, and on the end of the first length on the down-stream side an 18-in. valve was placed. Joints were all of Lead-Hydro-Tite. Before any more pipe was laid the rservoir was filed and some time later a washout occurred which completely undermined this length of pipe, leaving it and the gate suspended in the air and supported solely by the material in the joint near the masonry. Just what the maximum stresses were in the joint it is neither easy nor necessary to compute, but it seems to the writer that they are as great as are apt to be encountered under ordinary working conditions.

The writer has not attempted to take up the methods of using these compounds, or the minor difficulties attending their use for the first time with inexperienced men and incomplete equipment. These points have been covered in previous papers before the Association and in the literature with which the manufacturers keep us supplied.

It does unquestionably require considerable courage and considerable faith to give up the good old lead and substitute these new materials in the face of the inevitable opposition from calkers and doubt as to the outcome of the first day's work. The point that the writer wishes to make and to urge very strongly, however, is that we water-works managers and engineers cannot, with a clear conscience, go on using and specifying lead, if these other substances are safe and suitable substitutes. And it is "up to us" to find out whether or not they are safe and suitable or to make every possible effort to find out.

The bulk of the evidence, so far, points in one direction,—in favor of the substitutes. In the discussion that is to follow, let us hear from the other side,—the unsatisfactory experiences which, for our present purpose of getting at the truth, are perhaps the most valuable of all.

Several members took part in the discussion of this paper, giving personal experiences with these materials. E. E. Wall, water commissioner of St. Louis, stated that he had found it difficult if not impossible to properly control the temperature of leadite when using a coal fire built around a melting pot, as was used for melting lead, the tendency being to burn the leadite by having the fire too hot. Also, trouble was experienced by the fumes rising from the pouring pot directly into the faces of the men when pouring the joints. This condition was particularly objectionable on the work where leadite was used, because the trench was a narrow and unusually deep one. No cost figures were kept, but Mr. Wall did not doubt that, if properly used by experienced men, the cost of leadite joints would be less than those of lead.

In 1918, Mr. Wall had used metalium for about 1200 feet of six-inch pipe, and the trench was left open for about two weeks to determine the leakage. Immediately after the pipe was laid the leakage amounted to 2½ gallons per minute, the average during the first 24 hours was 1.3 gallons per minute, and was 1.15 during the second 24 hours. Before the trench was filled, the leakage had stopped altogether. Joints made with metalium in this case did not prove to be as cheap as lead, possibly because the men were unfamiliar with using the material. The last three lengths of pipe laid on this line were on a sharp up-grade of 3 feet in 36, and the change of grade was made at one joint. Afterward this pipe was lowered while under pressure, but no leakage at the joint resulted and no damage to the joint.

Cement was used for jointing about 800 feet of six-inch pipe in St. Louis in 1917. The water pressure on the joints ranged from 90 to 120 pounds per square inch and no leaks developed and no joints showed deterioration when the line was taken up a year later. (This line was used to supply a temporary camp). One bag of cement made 18 joints and twice as much jute was required as for lead joints. Three men mixed and made eight joints an hour. When making lead joints, two men attend to the lead pot, make rolls, run and caulk ten six-inch joints an hour. On the basis of these figures, with cement at $1.75 a barrel, labor at $2.10 and $2.42 a day, jute at 8 cents per pound and lead at 7 cents a pound, the cost per joint figures 98 cents for cement and $1.34 for lead. It was much more difficult to take up pipes with cement joints than those with lead joints.

The Atlantic City Water Department now uses leadite almost exclusively, the practice having been begun in 1901 by William C. Hawley, continued by Mr. Allen, and is now being practiced by Lincoln Van Gilder, present superintendent of water works. None of the joints laid since 1901 have shown any signs of deterioration.

An experiment made with leadite joints by the Boston Water Division was described by Frank A. McInnes, engineer of the department. Four lengths of four-inch pipe and one short piece were jointed with leadite and supported at each end, the supports being 48 feet apart, when the center deflected twenty-two inches, but without leakage or sign of failure. The center of the pipe was then loaded gradually but no leak developed until, under a load of 100 pounds, the pipe suddenly broke in two in the middle at a point 18 inches from the nearest joint. The deflection just before the break was twenty-five inches. Encouraged by this experiment, leadite was used for laying a pipe on a bridge carrying heavy traffic and street cars and therefore subject to serious vibration. This line had been in for five months at the time of this discussion and, although there was more or less dripping from the joints at first, this entirely ceased by winter when it was covered up to protect it from freezing.

The remainder of the discussion was devoted to the question whether leadite joints were conductors of electricity. The author of the paper stated that he had found it an excellent insulator and that he

had been unable to get a current to pass through it when endeavoring to thaw pipes by electricity. It was stated that the Boston Water Works had tried using a lead wedge on the bottom of each joint, and the same was used in Springfield. The members from these cities did not know whether the lead wedge was of any benefit, but George H. Finneran, superintendent of water service of Boston, stated that they had made a test in the yard, using volt meters, ammeters and other electrical apparatus. With solid leadite joints no flow of current through them could be observed, but when the joints were remade, using a lead wedge about 2½ inches long, two inches wide and ½ inch thick, placed in the bottom of the joint and driven in solidly, current was found to flow through the joint in amounts varying from one ampere to 400 and 14 volts to 30. However, when a test was made of pipe laid in the ground with leadite joints without lead wedges, current was found to pass through the main, indicating that the soil may have carried the current around the joints. In other cases, the current was found to pass from the pipe to a street railway track and back again, instead of through leadite joints. In another case he found that current passed from one pipe to another through a film or scale of what appeared to be rust, which had formed on the face of the leadite joint. He concluded that such a scale or the ground itself would serve to conduct the current, so that the use of leadite woud not interfere with using electricity as a thawing agent.

Water Filter for Mechanicsburgh

Work was begun the last week in June on a new one-half million gallon filter for Mechanicsburgh, Pa., which is one of the improvements which the Mechanicsburgh Gas & Water Company had been ordered to make by the State Department of Health, following the typhoid epidemic in that borough last February.

A typhoid epidemic in the spring of 1919 was investigated by the Health Department and attributed to the water supply. In February, 1920, a large fire so reduced the supply that the town was without water the following morning and the company turned into the mains water which had been insufficiently filtered, with the result that a typhoid outbreak occurred. In addition to the filter, the company is directed to install an electric emergency pump.

The citizens have been thoroughly aroused by these two typhoid epidemics and ten citizens have agreed to serve as deputy health officers and have been appointed by state commissioner Martin to serve in this capacity. These citizens serve without pay and the work performed by them has proved so satisfactory that commissioner Martin was said to be considering the appointment of similar committees in all of the boroughs of the state. Each week a sub-committee of two visits the water plant, examines the premises, obtains information as to the number of hours the pumps operate and other features of operation; while one of the members, who is appointed official water tester, obtains three samples of water in the borough and sends them to the Health Board for examination.

Elmira's Municipal Water Plant

The water works system of Elmira, N. Y., had been under municipal control for five years on April 3, 1920, and during that time paid out from the earnings $137,178 for additions and extensions and paid off $115,000 in bonds, giving a total gain to the city of $252,178. During the same period rates have been reduced for the small consumers whereby they have saved over $15,000 a year during the past three years. The old minimum charge was $3 per quarter, limited to 1,000 cubic feet. Many householders were using only 500 or 600 cubic feet per quarter and the minimum rate was therefore reduced to $1.50 per quarter for 500 cubic feet.

The $137,178 spent for extensions was used to add 13 miles of mains from 12 inches to 2 inches in diameter, 1,355 new services, for the purchase of a truck for hauling pipe, etc., and a Ford car for the meter department. When the plant was purchased there were in the pumping station a Worthington high-duty, cross-compound steam pumping unit with a capacity of 7½ million gallons per day, and a Worthington electrically driven pump of the same capacity. Both of these pumps had outlived their usefulness and in the second year of the city's ownership they were replaced with more modern units, these being a horizontal steam turbine connected to a centrifugal pump and a single-stage double-suction centrifugal pump with horizontal shaft direct connected to a 300 h.p. 3-phase induction motor. The steam unit has been operated with a saving of coal of more than 20 per cent over the one replaced, and the electric power consumption fell from 85 k.w.h. per 100,000 gallons to 65.

At the filter plant the entire strainer system was replaced, and a liquid chlorine outfit was substituted for a plant for using hypochlorite. The high pressure distributing reservoir was relined in 1916 at a cost of $5,630, and a new concrete spillway and retaining wall were built at the storage reservoir at a cost of over $8,000. All of these improvements and extensions were paid for entirely from earnings.. Over $5,000 has been spent in lowering mains in many sections of the city to prevent freezing and still more of this work must be done before general manager H. M. Beardsley will feel sure that there will be no trouble from frozen mains.

According to the annual report: "Some little objection was made when the city first announced its intention of metering all services, but our records show that the great majority of takers have been benefited by the change and their bills reduced in size by the use of meters. The efficacy of the meter in checking waste is shown by the fact that during the first year of operation 1,602 million gallons were delivered to the city, while in the fifth year, with approximately 10,000 more people using water, only 1,578 million gallons had to be supplied. As a further prevention of waste, the Pitometer Company made a survey of the entire city last fall and all leaks which were discovered were repaired. It is considered that the saving in water formerly wasted will pay for the cost of the survey within a year. The saving thereafter will be reflected in the reduced amount of water pumped and the consequent saving in operation."

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Pneumatic Foundation Without A Caisson

The construction of foundations with pneumatic caissons, although sometimes unavoidable in very difficult bottom, in deep water, or where it is impossible to unwater open excavations, is generally objectionable on account of the slow and expensive work involved, which often gives a very high unit cost for the concrete placed by this method. In recent years the cost of pneumatic caisson work in many instances has been considerably reduced by the successive replacement of the costly steel caissons by wooden caissons and eventually by reinforced concrete caissons which involve the temporary use of very little material not necessary for the permanent structure, and by the use of detachable cofferdams that may sometimes be used repeatedly if there are several successive piers to be built at the same place.

In order to avoid the possible delay in reconstruction and duplication of cost, it is generally customary to begin the foundations with pneumatic caissons where there is reason to suspect serious trouble with open excavation, thus making it necessary to do all of the excavation under air pressure in the working chamber in a manner that is disadvantageous as compared with open excavation.

Very satisfactory and encouraging results have been obtained in several jobs by what is virtually a combination of the open cofferdam and pneumatic caisson method, namely, with the use of the so-called "air bell" as described on page 68 of this issue. In the work here illustrated, and in previous work successfully accomplished by the same contractor in the construction of a bridge across the Tennessee river at Chattanooga, work on the pier foundation was first commenced in an ordinary sheet pile cofferdam and as much of the excavation as possible and part of the concreting was done in the open at a great saving over pneumatic caisson work. When it became impracticable to complete the foundations in the dry on account of serious leaks in the bottom of the cofferdam, light airtight wooden caissons, called "air bells," much lighter, smaller and less costly than ordinary pneumatic caissons, were installed commanding only the difficult parts of the foundations, and were enclosed in concrete deposited under water on satisfactory bottom to seal the cofferdam. This enabled more concrete to be placed in the dry, enclosing and greatly strengthening the light caissons so that they were enabled to withstand air pressure and permit the relatively small amount of work remaining to be done in them under pneumatic pressure at a fraction of the cost that would have been incurred if all of the work had been done under pressure.

Rational Investigations for Aqueduct Design

In designing a costly and important structure, like the $15,000,000 Winnipeg Aqueduct, the simple adoption of standard features and provision of abundant strength based on ordinary assumptions of conditions and requirements does not, alone, secure the best results. With an unlimited amount of time and money they may indeed provide a considerable degree of safety and efficiency, but the conservative copying under new conditions of structures that have been carefully designed to suit other conditions does not suffice for the best results. A clear understanding and careful equating of all the elements of location, conditions, requirements, construction, maintenance, and operation are necessary to assure the results best suited as a whole to the advantage of the owners. To secure these, some risks must be taken and others should be avoided, some advantages should be made to balance other disadvantages. Many points can only be determined by wide knowledge, long experience and careful investigation and analysis of conditions and requirements that require a high degree of skill and good judgment.

This has been notably demonstrated in the design of the Winnipeg Aqueduct of which the principal features are discussed in the articles commenced in the July 3rd issue of **Public Works.** For good and sufficient reasons, it was deemed advisable to make the aqueduct of comparatively light construction, and many miles of it were built with thin walls, arch and invert that effected a very important saving over the heavier construction that would have been necessary with less thorough and careful investigation and design.

Much of the aqueduct is in swampy ground, supported on soft soil where great precautions were taken to prevent settlement that would inevitably have caused expensive and dangerous cracking. Investigations and experiments were very thorough and comprehensive and included many tests of full size inverts of reinforced concrete with different dimensions that eventually determined the dimensions of no less than 16 different inverts that were used at various places and under different conditions.

Some of the auxiliary structures were designed on original lines providing for unusual requirements, such as the protection of the intake from frost in the very cold climate and the proportioning of the arch and side walls of the horse-shoe shape conduit to resist the unusual action of the frost which at a depth of 4 feet from the surface

of the backfill was sufficient to expand the frozen crust and lift it entirely clear of the extrados of the arch leaving a lune shape void over the haunches between the concrete and the frozen clay. This occurred at points where the covering was ample to protect the water in the aqueduct from freezing and to maintain in it a temperature that varied only about 1 degree from the summer or winter temperature in the supply lake.

The surge tank designed to relieve the aqueduct from stresses produced by sudden variations of pump pressure, was of special construction with the overflow proportioned to absorb these variations by giving 6½ minutes for speeding up the velocity of flow from 1½ feet to 4 feet per second.

Another Scheme for Selling Bonds

A few weeks ago we called attention to a plan employed by the officials of San Francisco, Cal., for evading state provisions that bonds for their municipal water supply could not be sold below par, the idea being in brief to have the contractors take the bonds at par and then add to their contract, as a sort of bonus, a considerable sum to compensate them for accepting the bonds at a low rate of interest.

The State Highway Commission of California has evolved another scheme for disposing of $3,000,000 worth of 4½ per cent bonds to be used for carrying on the work of that commission, this being for these bonds to be purchased at par by the State Board of Control, that board in turn to sell them to a syndicate of bond brokers at a price which would permit them to realize 5¼ per cent interest on their investment. This would result in a loss of $192,414 to the State Board of Control, which loss would be made good by deducting that sum from the Federal Aid fund. The Court of Appeals decided a few days ago that this method of beating the devil around the stump must be held as a violation of the law, and that the only way in which the state could meet the situation was by having the people at a state election give permission for the issuing of bonds bearing more than 4½ per cent interest.

This failure to raise money may entirely stop all the highway work in the state, since money is necessary for the salaries of the Highway Commission's employees. It is reported that a number of contractors have been performing highway work under "promise to pay" and that they will bring damage suits against the state; but as the Highway Commission cannot legally enter into a contract for work until the money is in hand, it is questioned whether the contractors can recover for such work.

Essentials of Tunnel Design.

Besides geographic, commercial, financial, and economic considerations, the building of a great tunnel involves methods and details of construction operations which are inseparable from an accurate and rational design. This in turn, demands assumption and verification of conditions, accurate analysis and precise computations to determine the stresses involved and the strength and safety of the structure.

In the past these requirements have sometimes been met, or even more or less neglected, by arbitrary or rule-of-thumb methods or by an effort to secure great, but indeterminate strength in hopes that it might exceed the unknown stresses. In the case of the proposed North River Vehicular Tunnel there has been much discussion and some conflicting views have been expressed regarding the conditions to be encountered and the strength and safety of different types of construction proposed. To secure authoritative data, expert computations were made for the report of the consulting engineer recently published in our columns, general formulas were derived and were specifically applied to four different sizes of tunnels which had been proposed, and the possibility of flotation and the longitudinal strength were calculated.

This original work, of a nature not very frequently required in ordinary engineering practice, was thoroughly and carefully done, and was found to agree closely with some of the results obtained by independent calculations of other engineers favoring different construction from that recommended in the report. They also brought out some special analysis and provide a clear and complete investigation that should be preserved for its technical value, as reference, and for direct application to a class of tunnel construction that is likely to increase rather than diminish in future years.

It has long been possible to construct tunnels on land or in solid rock under water, but much uncertainty and danger has attended subaqueous tunneling through silt, sand and treacherous materials. These difficulties will be materially diminished by the cleaver understanding of the conditions here developed and improvements and safeguards can follow that will be of great value not only for railroad and highway tunnels but also for sewer, water, gas and other utility tunnels under rivers and harbors and in other difficult places.

Detroit's 20 Miles of Street Railway

Bids have been invited for the construction in Detroit of about 20 miles of municipal railway to cost about $15,000,000. The bids have been divided into three classes, for foundation work, for oak cross ties, and for all steel work, even including the spikes. The total quantities include about 95,000 yards of excavation, 115,000 square yards of steel rail and 7,000 yards of ½-inch crushed stone back-fill. Work has already been commenced on a portion of this system.

Galveston Causeway

Under provisions of the original contract, the board of managers of Galveston County, Texas have relieved Larkin & Sangster, Inc., Buffalo, N. Y., of their contract for constructing the causeway in accordance with the clause that permitted this action should the cost exceed $1,750,000, which it has done. The increasing cost of materials, labor and transportation have made it impossible to complete the contract within the bids but the work will be continued under the direction of H. F. Jones, the supervising engineer.

Waterworks Prices in 1914 and Now

Figures from waterworks officials, supplementing those given in the June 12th issue.

Since publishing, in the issue of June 12, figures from more than 100 waterworks officials in 36 states giving prices paid by them for waterworks supplies in 1914, 1919 and 1920, we have received reports from several additional cities which we give tabulated below.

PRICES PAID FOR CAST IRON PIPE

City and State	Average Price per Ton Paid in 1914	1919	1920
Connecticut:			
Rockville	$22.00	$56.30	.....
Kentucky:			
Covington	.....	.....	$70.50
Maine:			
York	21.70	.....	.....
Michigan:			
Detroit	21.45, 23.45	50.90-63.60	75.00
Minnesota:			
Ely	.....	69.78	.....
New Hampshire:			
Concord	22.00	.....	.....
New Jersey:			
Jersey City	21.00	47.25	.....
New York:			
Frankfort	21.00	.....	.....
North Carolina:			
Statesville	.....	48.50	.....
Pennsylvania:			
Harrisburg	20.74	49.85	76.80
Texas:			
Sulhpur Springs	27.00	64.00	90.00

PRICES PAID FOR SPECIAL CASTINGS

City and State	Average Price per Pound Paid in 1914 Cents	1919 Cents	1920 Cents
Illinois:			
Olney	3-4½	.....	.....
Kentucky:			
Covington	.....	.....	7½
Michigan:			
Detroit	2¾	8½	8¾
New Jersey:			
Jersey City	2¼	5.95	.....
New York:			
Frankfort	2¾	.....	.....
Pennsylvania:			
Harrisburg	2½	5½	7¾
Texas:			
Sulphur Springs	3	.....	7½

PRICES PAID FOR WROUGHT IRON OR STEEL PIPE

City and State	Unit	Average Price Paid in 1914 Cents	1919 Cents	1920 Cents
California:				
Upland	Pound	5	9	9
Massachusetts:				
Pepperell	100 ft. wr. iron	..	16.15	17.85
Nebraska:				
North Platte	Ft. 2-in. pipe	15	....	30
Plattsmouth	1-in. ft.	9	12	12¾
North Dakota:				
Dickinson	Ft.	80	188.75	.....

PRICES PAID FOR LEAD

City and State	Average Price per Pound Paid in 1914 Cents	1919 Cents	1920 Cents
Connecticut:			
Rockville	4¾	10	.....
Kentucky:			
Covington	6	11	11¼
Maine:			
York	4	6.70	.....
Massachusetts:			
Pepperell	.....	.....	8
Michigan:			
Detroit	3.75	6.25	.....
Minnesota:			
Ely	.....	8½	.....
Nebraska:			
Plattsmouth	9¾	11½	.....
New York:			
Frankfort	4½	6¾	.....
Ohio:			
Celina	8½	10½	11½
Texas:			
Sulphur Springs	6	8	9½

PRICES PAID FOR METERS, ¾ INCH

City and State	Average Price Paid in 1914	1919	1920
California:			
Ontario	$7.90	.....	$11.60
Upland*	8.00	$11.00	11.50
Connecticut:			
Rockville	12.00	15.30	15.30
Illinois:			
Olney	13.50	17.50	.....
Michigan:			
Detroit	7.72	9.40	9.95
Minnesota:			
Ely	.....	11.00	.....
Nebraska:			
North Platte	9.30	12.60	.....
Plattsmouth*	10.20	12.00	.....
New York:			
Frankfort	8.40	12'50	.....
Pennsylvania:			
Harrisburg	9.00	12.55	14.50
Texas:			
Sulphur Springs	8.40	10.60	12.00
Wisconsin:			
Watertown*	10.00	12.60	12.00

*⅝-inch meters.

PRICES PAID FOR VALVES, 6 INCH

City and State	Average Price Paid in 1914	1919	1920
California:			
Upland	$12.00	$15.00	$15.00
Connecticut:			
Rockville	11.00	21.00	.....
Kentucky:			
Covington	.....	.....	24.00
Maine:			
York	11.90	.....	.....
Michigan:			
Detroit	12.35	32.00, 41.00	.....
New Jersey:			
Jersey City	10.00	.....	25.00
New York:			
Frankfort	12.50	20.00	.....
Pennsylvania:			
Harrisburg	9.45	20.79	25.00

PRICES PAID FOR HYDRANTS, 2-WAY AND STEAMER

City and State	Average Price Paid in 1914	1919	1920
Illinois:			
Olney	$18.00	$35.00	.....
Kentucky:			
Covington	25.00	38.00	$39.80
Maine:			
York	33.50	61.10	.....
Massachusetts:			
Pepperell	.....	65.00	(2 way) 64.40
Minnesota:			
Ely	.....	52.75	62.50
Nebraska:			
Plattsmouth	.....	.....	50.00
New Hampshire:			
Concord	24 & 34	65	.....
New Jersey:			
Jersey City	.....	82.50	.....
New York:			
Frankfort	32.00	45.86	.....
North Dakota:			
Dickinson	55.00	80.00	.....
Pennsylvania:			
Harrisburg	23.85	55.60	66.50
Texas:			
Sulphur Springs	21.00	38.00	43.00

PRICES PAID FOR COAL

City and State	Average Price Paid in 1914	1919	1920
Delaware:			
Milford	$4.00	$8.00	$8.41
Illinois:			
Olney	2.35	4.65	5.10
Michigan:			
Detroit	2.51	5.19	6.18
Minnesota:	2.29	5.61	8.06
Ely	3.55	5.10	5.10
Nebraska:			
North Platte	3.75	.....	5.60
Plattsmouth	2.50	5.00	5.75
New Hampshire:			
Concord	9.00	13.00	14.00
North Dakota:			
Dickinson	1.94	3.80	3.80
Ohio:			
Celina	2.25	3.80	6.05
Pennsylvania:			
Harrisburg	.85 & .95	1.65 & 1.85	2.10 & 2.50
Texas:			
Sulphur Springs	3.75	5.25	6.50
Wisconsin:			
Watertown	3.95	6.48	7.88

PRICES PAID FOR FUEL OIL

City and State	Average Price per Gallon Paid in 1914	1919	1920
Massachusetts:			
Pepperell	.....	$0.13¼	.....
New Hampshire:			
Concord	.....	.28	$0.34

PRICES PAID FOR ELECTRIC CURRENT FOR POWER

City and State	Average Price per k.w. hour Paid in 1914	1919	1920
California:			
Ontario	$0.05	.....	$0.02 7-9
New Hampshire:			
Concord	.12	$0.12	.12
North Dakota:			
Dickinson	.02½	.02½	.04
Ohio:			
Celina	.03½	.04	.05¼

PRICES PAID FOR LIME (FOR PURIFI CATION PLANTS)

City and State	—Aver Price per Pound Paid in— 1914	1919	1920
	Cents	Cents	Cents
New Jersey:			
Jersey City	2 1-5	2.8	2.508
Pennsylvania:			
Harrisburg	1.70	3.00	.....

INCREASES IN WATER RATES, SALARIES AND WAGES

City and State	Percentage of Increase Since 1914 In superintendent's salary	In wages of other employees	Increase in water rates since June, 1919
	%	%	
California:			
Ontario	..	100	None
Upland	25	..	None
Connecticut:			
Rockville	..	38	None
Delaware:			
Milford	50	50	75%
Illinois:			
Olney	30	15	6%
Kentucky:			
Covington	50	50 engr. 30 others	None
Maine:			
York	25	100	None
Massachusetts:			
Pepperell	14	40	.....
Michigan:			
Detroit	38	25-100	None
Minnesota:			
Ely	52	50	None
Nebraska:			
North Platte	60	66-100	20%
Plattsmouth	..	60	.....
New Hampshire:			
Concord	..	..	125%
New Jersey:			
Jersey City	16	40	None
New York:			
Frankfort	..	50	None
North Carolina:			
Statesville	50	..	None
North Dakota:			
Dickinson	10	20	None
Ohio:			
Celina	40	50	20%
Pennsylvania:			
Harrisburg	20	50-100	None
Texas:			
Sulphur Springs	65	100	None
Wisconsin:			
Watertown	50	50	None

Garbage Disposal in Charleston, W. Va.

A special committee of the Chamber of Commerce has submitted a report dealing with the garbage problem of the city, the recommendation in which report may be summarized as follows:

1. The Charleston chamber of commerce recommends to the city council that negotiations be entered into at once with some reliable companies looking toward a contract for free garbage and rubbish collection and disposal for the city.
2. That as early as indications point to any favorable bids being submitted, a committee be appointed by the mayor to draft an ordiance requiring the householders to make proper separation of garbage and rubbish and to take such further care of it on his premises as may be of help to the collector, and to city sanitation.
3. That negotiations be entered into by the proper city authorities looking to the sale of the Estill street garbage plant
4. That we recommend the hog feeding as the most economical method of reclamation of our garbage at this time, and that we recommend a plant that will reclaim all valuable products from rubbish.
5. That if possible, a contract be entered into for a period of three years, with an optional extension to the company of another four years.
6. That the percentage or remuneration shall increase from a point below reasonable profit for the first year, to a corresponding point above for the third year, and for the remaining four years a reasonable mean be established.
7. That the contracting company shall give a commercial bond in the sum of $25,000 for faithful performance of their duty.
8. That at a proper time an ordinance be drafted to establish a sanitary type of garbage wagon, time of collections, and daily reports on a chart at the disposal plant showing the amount of service on each street and this chart to be kept by a representative of the health department.
9. That an ordinance be drafted giving a minimum punishment for throwing garbage over any river bank or in any unauthorized place, of five days in jail, or $25 fine, or both at the discretion of the court.
10. That the spirit and letter of our state laws may be not transgressed in that the contracting company shall charge the householders, in the years after the first, rates sufficient to total the remuneration agreed upon. But the city should reserve the right and be honor bound to pay for the service out of the budget for each succeeding year after the first.

The largest single furnace incinerator in the country is now in Galveston, according to W. B. Vinson, superintendent of garbage and drayage. It is a modern plant in every respect. It has shown a capacity of forty tons every twenty-four hours. The old incinerator will be rebuilt so that the city will have the service of two plants.

A proposition is before Congress for the provision, in successive years, of a total sum of $350,000,000 for the reclamation of unused lands in the west and south.

A $90,000,000 Water Supply Project

The East Bay, Cal., Water Commission, recommends construction of a 127-mile aqueduct to the Eel river to supply 250,000,000 gallons of water daily to the cities of Oakland, Berkeley, Alameda and Richmond, with an aggregate population of 370,000 people.

This system is considered a desirable alternative to that of joining with San Francisco in the Hetch-Hetchy proposition.

Chief Engineer Philip E. Harroun reports in favor of a system comprising a storage dam, diversion dam and a 127-mile aqueduct including 30 miles of tunnels, 6 miles of concrete conduits, and 91 miles of steel and concrete pipe with a subaqueous crossing 2 miles long and 600 feet below the surface of Sarquinez strait. It is estimated that this system will cost at least $56,000,000 less than the proportionate share of the cost of the Hetch-Hetchy system, and that the cost of $90,479,000 can be reduced to $82,229,000 by the development of hydraulic power from the supply.

Bridge Work in Rumania

Owing to the general destruction of bridges during the war, there is an exceptional opportunity for American bridge builders in Rumania. There are eighteen important bridges to be reconstructed besides the great bridge over the Danube at Lernevoda, known as the King Carol bridge, 1,260 feet long and 11.4 feet above high water. In addition it is planned to erect a bridge over the Danube to connect Rumania with Serbia.

Concreting Plant and Operations*

By Frank W. Skinner

A general review of advanced practice in field operations, and equipment for important concrete construction. Principal methods of loading, unloading, transporting, storing, reclaiming, and delivering cement and aggregate. Measuring and mixing cement and aggregate, character and installation of mixer, delivery of concrete from mixer to forms, methods and apparatus for distribution and placing.

HANDLING CEMENT

Cement is delivered for the job in bags by rail, by boat, and by automobile trucks and, with the exception of small quantities for daily supply, should be stored in a weather-proof building on a platform elevated beyond danger of moisture from below. One-story wooden sheds 20 to 40 feet wide are often built for the purpose and may frequently be so advantageously located that the cement is unloaded by hand on the floor and can be delivered by hand carts or through chutes to the mixing machine. If the storage house is not adjacent to the railroad and large quantities are to be handled, it will often be advisable to install some sort of loading or conveying apparatus to handle the bags; for this purpose belt conveyors, derricks with skips or large buckets, or locomotive cranes are most frequently available. Sometimes the cement can be stored in a building forming part of the permanent construction, where it is usually handled direct from cars or trucks or brought into a lower floor on carts or wheelbarrows and piled by hand.

In some cases economy is effected by purchasing the cement in bulk, in which case it is usually shipped in box cars like grain, or in open-top cars thoroughly protected by tarpaulins. It can be unloaded by hand shoveling which, however, is very dusty and disagreeable, or by means of a mechanical shovel or scraper operated by power to transfer it a short distance to the storage bins. Open top cars may be unloaded by a clam-shell bucket operated by a derrick and delivering to adjacent storage bins.

The cement storage bins may be adjacent to or independent of the aggregate bins and should have an inclined bottom provided with one or more gates and chutes or spouts delivering by gravity to the batch container or directly to the mixer. A convenient form of outlet has a double valve with reciprocating parts so that, when one gate is closed, the other is open, and the required quantity for one batch is thus automatically measured and delivered by each operation of the controlling lever. A vent pipe is sometimes extended upwards from this apparatus to prevent the formation of a vacuum in the valve. Bulk cement may be elevated to the storage bins by bucket elevators operating in a boot on or near the car or boat; and bag cement may be conveniently handled in a horizontal or inclined position by endless belts, or in vertical or inclined position by bucket conveyors.

*Paper by Frank W. Skinner, published in Cornell Civil Engineer, April, 1920.

TRANSPORTING AND HANDLING AGGREGATE

Sand, broken stone and gravel are all handled and stored in substantially the same manner and all of them may be purchased, secured by the constructor at a remote point, or sometimes produced on the job. If the job involves excavation, such as tunneling, canal, reservoir and some kinds of road work, the stone encountered, if of suitable quality, can be broken to size in a portable crusher, elevated in a bucket elevator to a series of revolving cylindrical screens that deliver it according to size to different elevated bins, from which it is removed as required to general storage or to the mixer plant.

Sand, which may be derived directly from the excavation, can be treated in the same manner and may or may not require screening. In some cases it may have to be mixed for grading or may require washing, and for these purposes special apparatus can easily be designed and applied.

Gravel may also be derived from excavations on the work, or from a remote bank. It may or may not require washing or screening and, under certain circumstances, it may be found with sufficient fine material to serve both for stone and sand, requiring only the addition of cement to make concrete; but this is an unusual occurrence and requires close and constant attention to see that the quality and proportions remain satisfactorily constant. Frequently sand and gravel can be dredged with a clamshell bucket or dragline scraper in the bottom of a river, lake or pond and delivered by the dredge directly to the washing and screening apparatus; here it is cleaned and classified for the required purpose and finally delivered, usually by gravity or by gravity and bucket conveyors, to the storage bins.

The cost of the aggregate is a very important element on a concrete job, and the source, transportation and handling should be carefully investigated before any plant is installed or system adopted. Various systems have been well perfected and much standard equipment can be secured, all of which should be compared and the advantages and disadvantages of the different systems, or of a combination of systems, should be carefully studied. Estimates should be made, and the final plans should give due consideration to the rapidity of the work, the availability of different kinds of equipment and the salvage value after the work is finished. Preference should be given, of course, to well established methods and standard plants, rather than to untried or experimental features; but the engineer should have sufficient experience and ability to com-

bine, modify or adapt, and even to invent, if the available systems or apparatus are not satisfactory, or if special details are necessary.

The ultimate criterion must, of course, be the total cost of the finished work, unless the latter be subordinated to special considerations of rapidity or coordination with other parts of the work; these principles govern the mixing and distribution of the concrete as well. It may in some cases be more advantageous in the end to do a large amount of hand work, where there is available labor that is otherwise idle, or where it is desirable to keep a large force on hand to maintain the organization or provide for emergencies, or where slow work is preferable to rapid, or where it is difficult to obtain the necessary mechanical equipment.

It may also be more advantageous to pay a large unit price that does not involve much waste, deterioration, or heavy investment in special machinery or perishable equipment, rather than to install an elaborate or costly plant that will take a long time to erect and is not readily salable or useful afterwards, even though the operating cost per unit of concrete is very small.

Plant that is on hand should be utilized if practicable without too serious inefficiency, and the selection of new plant should largely be influenced by the ease and rapidity of securing and disposing of it, its salvage value, and its probable value to the owner for future work, thus making standard appliances always preferable. The cost of storing and transporting plant and the probable cost of maintenance and repairs, as well as the possibilty of renting it from other builders or of letting it when not in use, is also to be considered.

In all operations where a suitable location and arrangement can easily be secured, the movement of materials by gravity will generally be found advantageous even if it necessitates, as it generally will, hoisting materials in one way or another to a considerable height.

The greatest efficiency and economy is attained when the aggregate can be handled directly and continuously, for the minimum horizontal and vertical distances, from the source of supply to the mixing machines without interruption for rehandling, save for the maintenance of efficient permanent storage to insure against delays, breakdowns and interruptions.

STORING AGGREGATE

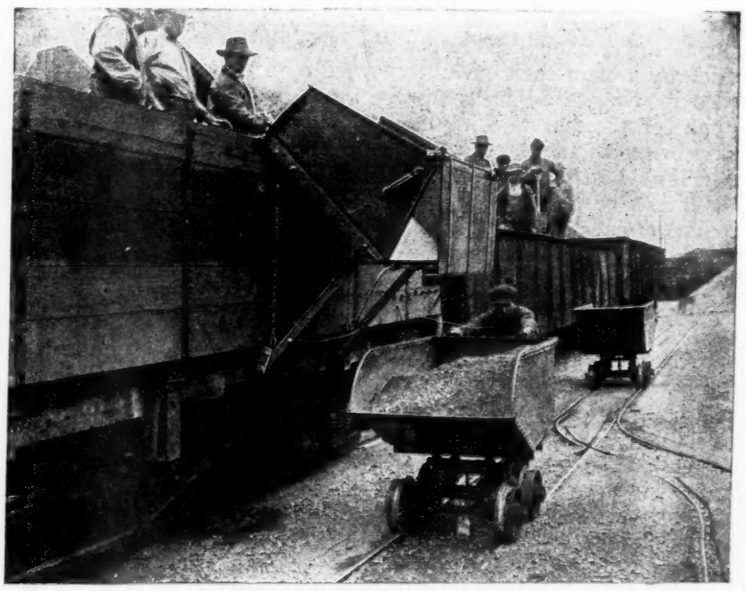
Cars, gondolas, scows, barges and the like are usually unloaded by clamshell buckets operated by derricks or by cableways. The clamshell buckets may deliver directly to storage bins or to storage piles, whence the material is reclaimed, sometimes, by the same buckets filling loading-hoppers, from which trucks are loaded at ground level.

When the aggregate can be delivered in bottom dump cars, the latter can discharge to the boot of a bucket elevator delivering directly to the bins, and it may be provided with a butterfly valve, enabling sand and gravel or broken stone to be shifted from the same elevator to either of two or three bins.

If possible, the storage should be located on a side hill where the material is delivered at a height sufficient to enable it to be moved from storage by gravity. When this cannot be arranged, it is often good policy to build an inclined track on a timber trestle high enough to afford sufficient storage for the aggregate on the surface of the ground below or, what is often more convenient, to enclose the sides of the trestle with heavy planking forming a bin underneath the track, that is filled directly from the cars above. This bin should be provided with bottom gates for the delivery of the material as required.

When the material is stored on the ground, whether it is delivered by trucks, derricks, cars or otherwise, it may, in case of side hill storage, be piled up against a wooden bulkhead on the lower side that will enable it to be drawn off through gates; or it may be piled up against a bulkhead on level ground that will afford the same opportunity to a lesser degree. When delivered by automobile trucks, it is possible to build up a plank runway on the slope of the material and drive the trucks to the top of the pile, thus securing a large storage in one place.

One method of loading which is often found very convenient and economical is to excavate a narrow trench across the ground where the storage pile is to be made, install a narrow gage service track in the trench and cover the top of the trench with a plank floor in which gates are set at intervals corresponding to the distance apart of cars, center to center, in tiling on the service track. The material is then piled to any convenient height over the trench, and cars on the service track can be filled by gravity. This method involves shoveling or other rehandling to deliver material from the outside of the lower part of the storage pile.



SHOVELING AGGREGATE INTO PORTABLE QUICK UNLOADING CHUTE

Sometimes aggregate is delivered to the top of a storage pile by a four-wheel skip hauled on an inclined railroad. Sand and gravel have, in some cases, been transported for several hundred feet to storage piles or bins by water carriage through pipes or wooden flumes. When it is necessary to unload open top cars by hand, portable chutes can often be used to advantage. These are light steel troughs that can be hooked on the upper edge of the car and project over a truck or cart on the ground below. They are wide enough to accommodate two or more shovelers, and their length and inclination are sufficient to deliver the material rapidly to the truck at a convenient distance from the track and reduce the work of shoveling to a minimum.

Where it is necessary to take aggregate from the storage pile on the ground, a good result can often be obtained by a mechanical loader, of which there are several types, the general principle being that of an inclined bucket elevator mounted on wheels and operated by electricity or gasoline. The bucket elevator can be elevated or depressed, so that when the machine is backed up against the face of the storage pile the bottom buckets will engage the toe of the material and carry it to the top of the incline, where the reversing buckets dump it into the car or truck which the elevator overhangs.

DELIVERY TO MIXER

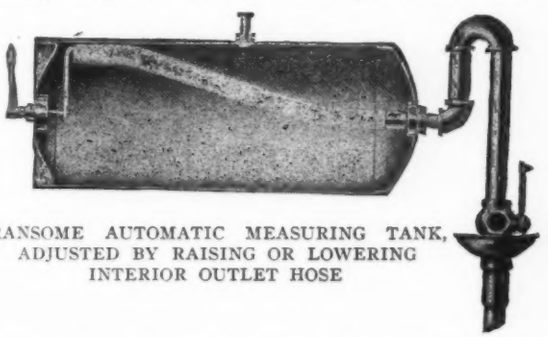
When the mixer can be advantageously installed adjacent to the storage, and the latter can by gravity, deliver directly to the charging hopper, the conditions are then most favorable for rapid and economical work. If this cannot be arranged, it is very desirable to establish a secondary storage at the mixer with a capacity for at least a half day's work, so that mixing can be carried on continuously irrespective of slight irregularities in the delivery from the main storage. The latter should of course have capacity sufficient to continue the work over any period where there is likely to be any interruption of supply due to the weather, transportation difficulties, labor troubles or plant break-downs.

When the main and secondary storage are not more than a few hundred feet apart, it will probably be advantageous on very large work to install some sort of continuous or semi-automatic delivery, such as endless belts, balanced inclines or, if possible, gravity spouting. If these are not practicable, resource will have to be made to some sort of car transportation, or to hauling by hand, team, automobile or locomotives. Delivery to the second bin should be so arranged that the aggregate from it can be drawn by gravity into the charging hopper, and this bin may be filled by any of the methods suitable for the main storage bin.

SKIP CAR FOR HAULING AGGREGATE UP INCLINE

If dump cars can be used, they are preferable; but when not available, flat cars may be used with detachable bodies, or independent skips, or buckets that can be handled by the derrick. In this case it is often desirable to have the bodies, buckets or skips accurately proportioned for the exact amount of aggregate necessary for one batch of concrete, so that they may serve as measuring boxes and may be emptied directly into the charging hopper; this saves rehandling, and maintains the contents of the secondary bin as a reserve using it only when there is an interruption of the supply direct to the mixer.

Wooden measuring boxes can usually be made to advantage by the contractor himself, of design and proportions suited to the special requirements of the work. They may be made with separate divisions for stone, sand and cement; or they may have one or two adjustable interior marks, suited to different proportions for one batch. A number of such boxes loaded on a train of flat cars and passing under the spout of the storage bin can be very rapidly filled with the successive materials. When an automatic measuring device is applied to the cement chute, only one mark or gate is necessary in a batch box. This may be placed low enough in the box so that the bottom is filled with sand up to that level, after which the box is put under the cement bin, and the required quantity of cement is automatically discharged into it without special measurement. Then the box is taken to the stone bin and filled completely full with stone or gravel. There are many different patterns of standard cast iron and steel gates for delivering stone, sand and cement, and it will usually be profitable to install them; but in case of necessity a contractor can easily arrange a gate, made of steel plate and timber



RANSOME AUTOMATIC MEASURING TANK, ADJUSTED BY RAISING OR LOWERING INTERIOR OUTLET HOSE

frame, that will work very well. Water should be delivered to the mixer drum, after the dry aggregate and cement are charged by an adjustable measuring tank with provisions for heating, if necessary in cold weather.

(To be continued)

To Irrigate 1,750,000 Acres

The Northwest Reclamation Congress, which will meet in Seattle September 16 and 17, will be the greatest irrigation congress in the history of the Pacific northwest. The congress will probably stress the necessity of developing the great Columbia Basin project of 1,750,000 acres, the most stupendous irrigation proposition in the history of the nation, which will increase by more than half the total taxable wealth of the state of Washington.

New Water Supply Works of Winnipeg*

By James H. Fuertes

This installment describes the surge tank, and gives a brief review of the completed works previously described in detail.

PROTECTION OF LINE FROM STRAINS DUE TO SURGING

An inspection of the diagram in connection with the variations in rates of draft between minimum and maximum rates shows that provisions had to be made to protect the portion of the aqueduct betweent station 900 and Winnipeg against excess pressures due to surging of the water in response to changes in velocities of flow caused by more or less sudden variations in draft, particularly when the booster pumps at Red river would be thrown in or out of service. These pumps are to be installed with a capacity of 50 million gallons daily, so that pumping can be done at a rather high rate for short times daily rather than be continuous. The storage capacity of McPhillips street reservoir makes this feasible and simplifies the pumping machinery.

In order to limit the excess pressures from the above causes, the aqueduct has been connected to a stand-pipe with an overflow with its lips at elevation 785.5, a height somewhat greater than required for the delivery of 28,500,000 gallons daily into McPhillips street reservoir by gravity; and an overflow has been placed on the gravity flow section at station 900+30 with its lips at elevation 797.60. The last mentioned overflow will protect the gravity flow aqueduct to the east of the 8-foot diam. circular pressure section, and the two overflows, combined, will prevent excessive pressures in the portion between station 900 and Red river.

THE SURGE TANK

The surge tank is a reinforced concrete structure, circular in plan, containing a central well, into which the aqueduct discharges, 25 feet in diameter and with its top edge at elvation 785. This well is inside of, and concentric with, a second concrete well 32 feet 6 inches inside diameter, with its top carried up to support a reinforced concrete roof, the under side of which is at elevation 294.75, or 9 feet 8 inches higher than the overflow lip.

Both of these circular wells are carried on a heavy circular concrete base some 8 feet in thickness, resting on a grillage of reinforced concrete and heavy steel beams encased in concrete, carried on eight concrete piers, extending to solid rock about 34 feet below the inside bottom of the surge tank proper. Surrounding the whole structure, and separated from it by an annular space 2 feet 9 inches wide at the bottom reducing to 9½ inches at the top of the structure, is a brick facing with stone base, belt courses and cornice. This design is primarily due to the necessity of conserving the heat of the incoming water in order to prevent the freezing up of the first annular space when overflows take place in winter weather. The water overflowing the inner circular well escapes to the river through a 36-inch cast iron pipe line.

The original calculations showed that a tank 20 feet in diameter would be large enough to limit the extreme downward surge to a practicable limit, under the assumption of a discharge at the rate of 18.9 million gallons daily into the tank being suddenly increased to a discharge of 51 millions daily by throwing in a booster pump of that capaity. This proceeding would increase the velocity in the 5-foot 6-inch pipe line from 1.47 feet per second, prevailing before the booster was started, to 4.00 feet per second when full discharge was established. An analysis by a process of arithmetic integration at 20-second intervals of time indicated that the lowest dip of the surge reached an elvation of 751.1, and then started to rise again about 6 minutes 20 seconds after starting the pumps. The low point was about 2.3 feet below the final level for a continuous discharge at a velocity of 4 feet per second. The maximum discharging velocity 4.1 feet per second, was reached in about 8 minutes 20 seconds after starting the pumps. The upward surge from the low point was not followed out in the analysis; neither was the surge from sudden shutting down of the pumps, which would be the maximum to be expected, as these would be entirely checked by the spilling of the water over the overflow lip.

The original plan was for the use of a 5-foot steel pipe line from Deacon to Red river and a 4-foot cast iron pipe from Red river to McPhillips street reservoir, and to pump the water from Deacon to Winnipeg at service pressure. As has been pointed out, this plan could not be followed out on account of the conditions in the Districts' Act of Incorporation, although, of course, the pipes could be used as recommended; but as the new conditions did not require such strong pipes, studies were made which showed that reinforced concrete pipes could be substituted for those originally proposed, and a new plan of operation be evolved which would reduce the cost of construction and operation while at the same time providing for the delivery of larger quantities of water to the McPhillips street reservoir by gravity. This change was submitted to Mr. Hering and Mr. Sterns, of the original board of consulting engineers, and had their approval.

GENERAL DESCRIPTION OF COMPLETED WORKS

Reviewing the subject, it will be seen that the works constructed include the following:

1. Intake at Indian bay.
2. Venturi meter in the depressed section under Falcon river, about a mile from the intake.
3. Gravity flow aqueduct on various grades, capacity 85 million gallons daily, from Indian bay to Station 900, a distance of 80.54 miles, with a connection at Station 4,618+10 (Mile 87.5) for a second aqueduct in the future.
4. 8-foot circular reinforced concrete aqueduct, built in trench, from Station 900 to Deacon (Sta. 678+72.5), a distance of 22,127.5 lineal feet (or 4.2 miles), running in service un-

*Continued from page 60.

der heads of from 10 to 30 feet; capacity 85,000,000 gallons daily.

5. Venturi meter in 8-foot pipe line, then offtake pipe to Deacon reservoir, then 5-foot shut-off gate in aqueduct, then intake of 5-foot 6-inch line from Deacon reservoir, then Venturi meter on 5-foot 6-inch line. These two meters, the two offtakes, and the shut-off gate in the 5-foot 6-inch conduit, are all in a stretch of 294.5 feet of aqueduct, measured along its center line.

6. Then a 5-foot reinforced concrete pipe from Deacon to the surge tank at Red river; total length 49,900 feet, delivering water to the surge tank at the maximum practicable rate of 59 million gallons daily from Station 900 to the 36-inch outlet connection for Transcona, 56.5 million gallons daily to the 36-inch outlet connection for St. Boniface and St. Vital, and 35 million gallons daily from St. Boniface to the surge tank. A 24-inch outlet, also, is provided at Archibald St., for the Elmwood district and East Kildonan.

7. The surge tank at Red river.

8. Tunnel under Red river, with connections at the top of the east shaft for the booster pump which will, later, pump water from the surge tank to the McPhillips St. reservoir in quanities up to 35 million gallons per day, but at rates up to 50 million gallons per day.

9. 36-inch connection at top of west shaft of tunnel for a future supply of water to the high bank of Red river, where the west shaft of the tunnel is located, and a 24-inch connection for Fort Garry.

10. A 48-inch reinforced pipe from the Red river tunnel to McPhillips St. reservoir in Winnipeg, with a 24-inch outlet at King St. for Kildonan and a 24-inch outlet for Assiniboia at Arlington St. In this pipe line a Venturi meter has been placed just before the pipe reaches McPhillips St. Reservoir.

The capacity of the 48-inch pipe line and 5-foot 6-inch line, acting together to deliver water by gravity to the McPhillips St. reservoir, is 28.5 million gallons per day at the maximum rate of consumption, which will be reached when the total consumption from this center approximates an average rate of a little over 20 million gallons per day. When that time arrives, the booster pumps at Red river will be required and quantities representing average daily rates up to 15 million gallons above the 20 millions will have to be pumped to McPhillips St. at rates approximating 50 million gallons per day, to keep the reservoir replenished.

As has been stated above, when more than 25 million gallons daily is required in Winnipeg, Kildonan, Assiniboia and Fort Garry, the additional quantity is to be pumped from a proposed new reservoir to be built at St. Boniface. Stop-plank chambers and overflows, as well as blow-offs, have been put at all the principal river crossings and at the end of the gravity flow aqueduct at Station 900+30, in addition to the large gates in the intake structure for the purpose of regulating the rate of flow in the aqueduct as required, and to prevent upward pressure on the roof or arch of the aqueduct in case of accident of any kind.

Labor Notes

The general contractors of New Orleans refuse to pay the $1 per hour wages demanded by the striking unions, and have advertised for 1,000 carpenters to work on open shop basis. Gov. Parker awarded a scale of 90c per hour for the first three months, 95c per hour for the next three months, and $1 an hour for a year thereafter, but it is not acceptable to employers.

The strike of the Providence hodcarriers and building and common laborers' unions in Providence, which has been in progress since May 1, has recently been settled by the intervention of the Building Trade Council. The officers of the laborers' union were restrained by a court order from taking an active part in the conduct of the strike and the Building Trades Council urged the acceptance of the offer of 60c and 65c an hour made by the Master Builders' Association. The unions demanded 70c and 75c but eventually accepted the 60c and 65c offered.

Advices from Cleveland, where there has been recently much labor trouble and very high prices, state that at the recent annual conference of the independent sheet, tin-plate, and bar iron manufacturers with representatives of the Amalgamated Association of iron, steel and tin workers, the radical demands of the latter, not for hours or wages but for unionization of the mill crafts tending to create closed shop and extend sympathetic strikes, have been refused by the employers and that it is likely, and that many manufacturers are now making their plans with the expectation, that the steel and iron mills will be closed on July 1 and August 1 when their respective wage agreements terminate.

Many large industries are said to be leaving Chicago and locating in Omaha and Kansas City because the labor conditions are better in the latter places, and because the compensation laws, taxes and financial matters in Chicago make excessive demands on the large firms, thirty of which are said to have moved west from Chicago during the past year.

Pay According to Efficiency Increases Production

Experiments conducted by a New Bedford, Mass., cotton manufacturer resulted in a 40% increase of output by installation of piecework system in every job on which it is practicable. The mill runs on an eight-hour day.

"Moral Strike Support"

In a recent article the Boston Herald justly scores the American Federation of Labor for its treasonable declaration at the Montreal Convention of "Moral support" and "endeavor to obtain their reinstatement, for the striking Boston Policemen." The Herald commented on the tremendous public approval showed to Gov. Coolidge's action in discharging the policemen by giving him an unprecedented majority in his subsequent re-election, and thinks that the federation's defiance of public.

sentiment will be unequivocally answered at the polls next November by the election of Coolidge which can only be interpreted as endorsement of his honest and loyal records and an assurance that the popularity of unjustified strikes is very small.

Governor Parker of Louisiana, acting as arbitrator of industrial canal workers' demands, has allotted 90c an hour for next three months; 95c an hour for following three months, and $1 an hour for a year thereafter; ruling affects about three thousand workmen.

Although the proportion of immigrants that land in New York City is less now than formerly, the records show that from January 1st until June 27th, the arrivals here totaled 152,987 and that the maximum daily number of 6,200 was considerably in excess of the facilities for caring for them, so that Commissioner of Immigration Fred A. Wallis was obliged to demand from the secretary of labor, authority to add 20 more inspectors and 20 more guards for immediate service.

Increased Immigration Expected in The West

The director of traffic of the Southern Pacific Railroad Company states that the company is preparing for a very large immigration, has reopened its European offices, and is making special efforts to interest Europeans in American prospects and conditions. It is believed that whenever the transportation is adequate there will be marked increase of laborers, and argricultural workers will probably be willing and glad to work for more reasonable hours and rates than now prevail.

The Immigration Wave

On July 13th there arrived at Ellis Island 10,132 European immigrants, the majority of whom came from Italy and other Mediterranean countries, with a few from Great Britain and some from Holland who had escaped to that country during the war. There are plenty of immigrant women, and as none of them apparently intend to do housework, but are going to the factories, they may release some of the men there for agricultural and construction services, so much needed.

Boosting Municipal Wages

Last May the city of New York raised the wages of common labor to $5 per day, and now Local Union 94, composed of city employed laborers, demands that the wages be again increased to $7 per day for such work as watchmen, caretakers and other common labor.

Closed Shop Won't Help St. Louis Carpenters

The Building Industries Association, composed of contractors employing half of the 4,000 carpenters in St. Louis, has announced that pending settlement of the strike of union carpenters who were refused their demands of a raise from $1 to $1.25 per hour, they will employ only non-union carpenters. This is apparently equivalent to putting the closed shop on the other side of the question where it may not appeal so strongly to labor unions as when it operates in their favor. It is reported that the city is paying $1.25 per hour for carpenters in violation of the ordinance which forbids the payment of more than the prevailing rate of wages. A committee has therefore been appointed by the Master Builders' Association to protest against this over-payment, and if it is not discontinued, to take legal measures to compel it to be stopped.

Lack of Transportation Stops Work

At Cleveland a few days ago the sand and gravel interests testified before the Interstate Commerce Commission that building has been halted and thousands of men are idlle because of the lack of open-top cars.

Public utilities are threatened with disaster and industry is badly handicapped because of the transportation situation. The modification of the fuel priority order is requested and Donald Willard, president of the Baltimore & Ohio Railroad and chairman of the advisory committee of the association of railway executives, pleaded for co-operation between the railroads, the shippers and the Interstate Commerce Commission, stating that it was necessary for the priority order to be enforced for a while longer and predicting better handling of the traffic by the railroads when the labor troubles are relieved.

North Carolina to Boost Highways

There will be a meeting of the good roads advocates from all sections of North Carolina in Raleigh on August 10th, the first day of the extra session of the general assembly of the state. The purpose of the meeting was stated by Colonel T. L. Kirkpatrick, president of the Wilmington-Charlotte-Asheville Highway Association, to be to convince the members of the legislature that the citizens of the state are anxious for modern hard-surface highways throughout the state.

It is proposed to submit to the people in November a referendum for a $50,000,000 bond issue for good roads.

Additional Water Supply for Philadelphia

Philadelphia is approaching the limit of its present available supply of water, and Carlton E. Davis, chief of the bureau of water, has recently taken up the matter with Mayor Moore, and under instructions from the mayor has conferred with water works experts on the subject.

Mr. Davis is considering the supply not only for the present but for fifty years to come, and believes that it will be unnecessary to bring water from distant mountains or from point outside of city limits. In addition to the Delaware and Schuylkill rivers, it is suggested that water may be obtained from artesian wells in the southern part of the city, an advantage of which would be that it does not need filtering, while the water from the rivers is far from pure and needs thorough treatment.

English Appreciation of American Engineering

It has been common practice for engineers and engineering periodicals in this country to refer to European experience and practice in engineering matters, as more generally satisfactory, though commonly more expensive, that in this country; and there has been a more or less general inclination to assume that engineers on the other side of the Atlantic need not pay much attention to what was done in this country along such lines. Readers of English periodicals, however, must have noticed the increasing attention and respect which is given to United States practices, and it may be well for us to realize that perhaps Europeans have as much to learn from us as we have from them. In fact, this may save us from mistakes of imitation. To cite only one illustration, it has become the practice here to refer to the English refuse incinerators as being a complete success in disposing of refuse without offsense and even so as to yield a net revenue. It was, indeed, reported that this was the case a decade ago, but references are becoming more and more numerous in the English technical papers to the dissatisfaction felt with English destructors by municipal officials, and they are even suggesting that much could be learned from practice in the United States in that respect.

Looking through the June 24th issue of *Municipal Engineering and Sanitary Record*, published in London, we find American reports and experiences referred to in five different articles. One of these cites our experience with cast iron pipe in confirmation of the long life of such material, another describes at length the Cobwell process applied to sludge utilization, as well as to garbage disposal; another refers to the better heating of American houses; another to the use of trailers and tractors for collecting municipal refuse, with the suggestion that the method employed in Utica, San Antonio and other cities in this country be given a trial in England; while another refers to experience in this country with bituminous concrete pavements.

In another issue we find a description of the use of concrete pipes, reinforced to withstand an internal pressure of 80 pounds per square inch, with special reference to the pipes laid in Baltimore some years ago and to the line laid later in Seattle. Another article recommends that the English take example from the United States in designing and using more artistic lighting standards, stating—"In the States the public lamp standard, which combines beauty with utility, has been brought to a high state of perfection, with the result that instead of being an excrescence, it fits in with the architectural character and the layout of streets and open spaces, and forms an important part of a general decorative scheme."

In a paper before an engineering society the writer is quted as saying, "While Great Britain has always taken preeminent place in all matters pertaining to road administration, it must be admitted that in recent years the Americans have gone a long way ahead in the quarrying industry. In spite of the higher costs ruling in that country, broken stone of excellent quality, well screened and suitable for road work or concrete, is being sold at half the price ruling here. This increased efficiency and consequent cheaper price have been achieved by the introduction of large crushing plants. A 54 in. x 42 in. American crusher, to work in conjunction with a mechanical shovel, is at present being erected in Scotland, and it will be interesting to watch what effect it will have in the future development of the quarry industry of that country."

What is Dry Rot?

The following information concerning "dry rot" is furnished by the Forest Products Laboratory of the United States Forest Service:

The term "dry rot," the Forest Products Laboratory finds, is applied by many persons to any decay which is found in wood in a comparatively dry situation. Thus loosely used the term actually includes all decay in wood, since wood kept sufficiently wet can not decay.

In the more limited sense in which pathologists use the term, "dry rot" applies only to the work of a certain house fungus called *Merulius lachrymans*. This fungus gains its distinction from the fact that it is frequently found growing in timbers without any apparent moisture supply; in reality it does not grow without moisture and is as powerless as any other fungus to infect thoroughly dry wood. Given moist wood in which to germinate, it is able to make its way a surprisingly long distance in dry timbers, drawing the water it needs from the moist wood through a conduit system of slender, minutely-porous strands.

Wood in the typical advanced stage of dry rot is shrunken, yellow to brown in color, and filled with radial and longitudinal shrinkage cracks, roughly forming cubes. In many instances these cracks are filled with a white, felty mass, the interwoven strands of the fungus. The decayed wood is so brittle and friable that it can easly be crushed into powder.

The dry rot fungus is active in nearly every region of this country, in Canada, and in Europe. It is very destructive to factory and house timbers and to logs in storage. Coniferous or soft woods are more commonly infected by it than hard words.

Street Cleaning Without Penalty

For the first time in several years no deductions were made by the Department of Public Works from payments for street cleaning in the 6th and 9th wards of Philadelphia during the month of June. It has been so common for such deductions to be made that the director of the department wrote to the contractors congratulating them upon the good work performed. The penalties imposed on the contractors for the seven districts for the month totaled $1,837.

Recent Legal Decisions

OBLIGATION TO PAY SUBCONTRACTORS AND MATERIALMEN UNDER CONTRACT AND SURETY BOND

The contract for the construction of a septic tank and appurtenance provided that the contractor should furnish satisfactory evidence "that all claims of all persons who have been employed upon the work, or who have furnished materials for the work under this contract and according to these specifications, have been fully settled." In an action by a subcontractor on the contractor's surety bond it was held, Northwestern Bridge & Iron Co. v. Maryland Casualty Co., Wisconsin Supreme Court, 177 N. W. 31, that "fully settled" here means paid and discharged. The court said: "If these clauses are not inserted for the benefit of laborers and materialmen why are they inserted at all? The contractor agrees to furnish the pay for all the labor and material going into the completed structure. He does not carry out his contract until he has done so. The trial court was right in holding that it was the intention of the contract to protect third parties who might furnish material or labor going into the work, by insuring payment of their claims, and that the defendant by the language of its undertaking became liable in the event of the contractor's default in that respect." Judgment for the plaintiff was therefore affirmed.

STATUTES PROTECTING LABORERS AND MATERIALMEN ON PUBLIC WORKS SHOULD BE LIBERALLY CONSTRUED

The Oregon Supreme Court holds, Clatsop County v. Fidelity & Deposit Co., 189 Pac. 207, that a statute, enacted to protect persons supplying a contractor performing a public work with labor or materials for any portion of the work provided for, should be given a liberal construction in order to carry out the legislative intention. It holds that meats used in a necessary boarding camp for laborers employed on a public highway in a sparsely settled region provided for in a contract secured by bond are within the term "labor and materials" under the statute and the person furnishing them to a subcontractor is protected by the statutory bond. The Oregon statute is practically a counterpart of the federal act of August 13, 1894, from which it was derived. The Supreme Court of the United States recently decided a similar case in the same way. Brogan v. National Surety Co., 246 U. S. 257. The typical lien laws of the states and the decisions of the courts upon them should, for the most part, be put aside in construing such acts. The following have been held by the federal courts to be protected by such bonds: Trucking from a steamer landing on an island where the work was to be done, to the particular locality of the work; coal supplied to a contractor and used to operate hoisting and pumping engines employed in the performance of a contract for the contruction of a dry dock; drawings and patterns made for the contractor constructing a steam vessel for the United States, from which to make molds and castings; towing in the delivery of materials, wharfage paid in connection with such delivery, and the local transfer or hauling of materials; and the use of equipment in the erection of a naval training station. The Oregon court holds, City of Portland v. New England Casualty Co., 189 Pac. 211, that food for horses used in the improvement of a street is "material" within the protection of the statutory bond, although admitting that on this point there appears to be a conflict of opinion in other jurisdictions.

EXTRA WORK NOT AUTHORIZED IN WRITING AS CONTRACT REQURIED

Where the work for which a bridge contractor claimed extra compensation was either required by the contract or clearly outside the contract and was not authorized by the commissioner of bridges in writing as required by the contract in the case of extra work, the New York Appellate Division holds, Snare & Triest Co. v. City of New York, 181 N. Y. Supp. 304, that the contractor was not entitled to recover therefor on the theory that the requirement that it do such work was a breach of the contract, since, if the work was not covered by the contract, it was within the provision as to extra work.

CLAIMANTS MUST JOIN IN ONE ACTION ON BOND OF CONTRACTOR FOR PUBLIC WORKS FOR UNITED STATES

In an action of a contractor's bond for public works, under Act of Congress, August 13, 1894, c. 280, as amended by act February 24, 1905, c. 778, providing that materialmen and laborers on public works may join in one action on the contractor's bond, etc., the Circuit Court of Appeals, Third Circuit, holds, Miller v. American Bonding Co., 262 Fed. 103, that the right of action is a new one, created by statute, and is not based on a common-law right of trial by jury, and a claimant refusing to proceed to trial at the same time as the other claimants, without offering any reason to the trial court for his refusal, is barred from subsequently maintaining a separate action on the bond.

STATUTORY DUTY TO PAY PAVING CONTRACTOR

A contractor furnished the labor and materials for the paving of a village street and his work was accepted, and used by the inhabitants. The village authorities refused to pay him the balance due, because the statute authorizing the work was not strictly followed in undertaking it and levying the assessment to pay for it. The New York Appellate Division holds, Dean v. Village of Wilson, 181 N. Y. Supp. 835, that, as the village trustees refused to pay this moral obligation founded in equity and justice, the Legislature had the undoubted right by statute (Laws 1919, c. 390) to compel such payment without invading the constitutional rights of any citizen, and that mandamus was the proper remedy to compel them to comply with the express direction of that statute.

NEWS OF THE SOCIETIES

August 14-18—ENGINEERING INSTITUTE OF CANADA, CALGARY, BRANCH. Meeting at Banff. F. C. Emery, secretary, western professional meeting, Calgary, Canada.

Aug. 26-Sept. 3—AMERICAN PUBLIC HEALTH ASSOCIATION. San Francisco. Office of Secretary.

Sept. 7-16 — NEW ENGLAND WATER WORKS ASSOCIATION. Annual convention, Holyoke. Mass. Secretary, Frank J. Gifford, 715 Tremont Temple, Boston, Mass.

Sept. 13-17—AMERICAN PUBLIC HEALTH ASSOCIATION. Annual convention, San Francisco, Cal.

Sept. 13-17 — SOUTTHWESTERN WATER WORKS ASSOCIATION. Annual convention, St. Charles Hotel, New Orleans, La. Secretary, E. L. Fulkerson, Waco, Texas.

Oct. 12-14—AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS. Annual convention, St. Louis, Mo. Secretary, Charles Carroll Brown, 401 Lincoln Avenue, Valparaiso, Ill.

NATIONAL FEDERATION OF CONSTRUCTION INDUSTRIES

Members service letter No. 30 dated July 9th deals principally with credit restriction and with the railroad transportation situation.

President Trigg, referring to the reports of a recent meeting between the Federal Reserve Board and the committee on deflation appointed by the executive council of American Bankers Asociation says, in discussing the responsibility of the local banker in connection with the program to deflate credit. "The success of his efforts will be measured by the care with which he discriminates in lending so that credit when required for the production of food or other articles of necessary consumption will not be restricted, while new loans for non-essential purposes will be refused and those already made will be gradually reduced."

In the present program of deflation through credit restriction, the local banker is left largely to determine what are essential and what are non-essential requirements for credit.

The perspective of your local banker may be improved if you will discuss with him the essential character of many local construction projects and point out to him that the community is laboring under a heavy and accumulated structural shortage.

In reply to a questionaire, a telegram addressed to 51 directors of the federation and presidents of member associations requesting them to express their opinions concerning the order of the Interstate Commerce Commission providing for a 30 day priority of open top cars for coal transportation, 26 answers were received and printed, abstracted or excerpted. Portions of these answers are published, of which 8 directly or indirectly endorse the priority order and a number of others submit to it as a necessary hardship or suggest alleviating modifications.

One association president wires: *Believe remedy worse than disease. Suggest priority coal orders for public utilities and reduced allotment for others—say sixty days.*

A Director wires: *I favor vigorous protest.*

An association wires: *Our association believes that efforts should be made to curtail indiscriminate delivery of coal to unneccessary uses if it curtails shipment of building materials for necessary housing.*

A state sand and gravel producers' association wires: *Believe in drastic steps being taken immediately; injunction if necessary.*

Another association president wires: *Believe we should protest vigorously against order placing open top cars exclusively in coal transportation.*

Another Director wires: *Judgement is that construction industry should make known its position in most emphatic manner possible. I doubt, however, the wisdom of injunction proceedings.*

Another association wires: *Request that you recommend modification of order, so that portion of open top cars may be available for building materials.*

Another association wires: *While we are suffering from car shortage, we are suffering more from effects policy Federal Reserve Board.*

KENTUCKY GOOD ROADS ASSOCIATION

The general meeting, convention, and exhibit of the "Kentucky Good Roads Association, the Kentucky state road engineers, the Fiscal Courts and All Allied Good Roads Interests," was held at the Jefferson County Armory, Louisville, Ky., June 15-16-17. There was a large attendance and excellent exhibits and the delegates were abundantly entertained by automobile rides through the park and luncheon at the Kentucky Culvert Manufacturing Company's Plant, by by a band concert and special musical entertainment and picture show in connection with the road machinery exhibit, and by a supper and receptionat Fontaine Ferry Park.

Among the principal papers and addresses were, Good Roads and Their Value to the State by Harvey T. Stout, Jr., an address by C. E. Drayer, sec'y. American Association of Engineers; "Statement of Future Policies of New State Highway Commissions" by the recently elected commissioner, Ben Weille; Discussion of New State Highway Law By Senator White L. Moss, Bell County, Pineville, Ky., Hon. Jos. F. Bosworth, Middlesboro, Ky., Jos. S. Boggs, Commissioner Public Roads, State Highway Department, Frankfort, Ky.

Three Minute Talks By—R. P. Duvall, Road Engr, Franklin County, Frankfort, Ky., Roland Pyne, Road Engr, Campbell County, Newport, Ky., C. B. Arnold, Road Engr, Boyle County, Danville, Ky; Discussion By County Judges of New Road Law—Presiding—E. O. Mills, County Engr, Kenton County, Covington, Ky., Judge D. C. Wells. Daviess Co., Ownsboro, Ky., Judge M. S. Mills, Pendleton County, Falmouth, Ky., Judge A. M. Caldwell, Campbell Co., Newport, Ky., Judge J. R. Lanchester, Scott Co., Georgetown, Ky., Judge Sam'l E. Dehaven, Oldham Co, La Grange Ky.

Highway Bridges-Addresses By Walter Bruan, Consulting Engr., Columbus, Ohio., Chas. D. Snead, Bridge Dept. Public Roads, Frankfort, Ky.

Talks on various Road Materials By Rock Asphalt-Rodman Wiley, C. E. Kentuckey Rock Asphalt Company., Concrete—C. D. Franks, Porland Cement Asociation., Tar Products—American Tar Products Co., Tar Products—Barret Company., Brick.

Some of the important exhibits displayed in the armory were additionally emphasized by 50 pages of advertising in the attractive program issued for the convention.

TEXAS ROAD BUILDERS ASSOCIATION

At the recent roadbuilders convention in Austin, the Texas Roadbuilders Association was organized with Prof. R. W. Tyler, University of Texas, President, R. V. Glenn, Ft. Worth, L. W. Kemp and G. E. M.

AMERICAN ASSOCIATION OF ENGINEERS

A long contemplated Industrial Department has formally been authorized by the Board of Directors of the Association. Steps are underway to organize this department and take up consideration of the problems of mechanical, electrical and chemical engineers and industrial work.

A. M. Cornell, chief engineer of the Pettibone & Mulliken Company of Chicago will supervise the activities of the department until such time as the duties warrant the employment of a full-time paid secretary.

Funds will be raised by setting aside $2.50 out of the entrance fee accompanying applications obtained by members in industrial work, or sent in by applicants working in industrial plants. This is the same plan used in building up Railroad Department and the Federal Department. Five men were recently recommended by the Tucson Chapter of the American Association of Engineers to act as highway commissioners of Pima County. These recommendations were made at the request of the county board of supervisors and the engineers so recomended have been appointed and placed in charge of an expenditure of nearly two million dollars on the location and two million dollars on the location and construction of new roads. The commission has already employed over sixty engineers.

TECHNICAL CLUB OF DALLAS, TEXAS

At its meeting of June 22nd, the Technical Club of Dallas voted to join the Federated American Engineering Societies.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS

At the meeting held in Montreal, June 28—July 3rd, the American Institute of Chemical Engineers favorable discussed joining the Federated American Engineering Socities and referred the subjects with power to the Council.

FEDERAL HIGHWAY COUNCIL

The transportation committee of the Federal Highway Council, Charles W. Reid (formerly executive officer of the U. S. Council of National Defense) chairman, has formulated a general policy to assist in coordinating highway transportation with other transportation agencies, encourage highway developments and stimulate its use so as to make them of maximum service, especially in facilitating and cheapening the transportation of food, raw materials and finished products. The purpose is "To Recognize the Problem of the Road Builder, to Realize the Needs of the Road Users, To Visualize Highway Transportation Requirements. To Cooperate with Railroads, and Waterways."

In order to facilitate cooperation with chambers of commerce, commercial clubs, civic bodies and other affiliated organizations, committees are being appointed to direct the work in its more important branches. The committee on policy towards other forms of transportation will make a close study of short haul and terminal problems, including transportation surveys, the motor-truck in terminal work, and motor-truck statistics.

The committee on rural motor express will study franchises, insurance, uniform receipts and bills of lading, marketing and return loads.

Special attention will also be paid to the study of highway transportation, functions of state highway department including snow removal, traffic surveys and traffic control, and the development of a policy of cooperation with motor-truck users organization.

Cooperation in educational work with universities and schools will be directed by A. H. Blanchard, professor of highway engineering, University of Michigan.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

At the annual convention of the American Institute of Electrical Engineers at White Sulphur Springs, West Virginia, June 30th, it was resolved that the institute should join the Federated American Engineering Societies but that on account of the small attendance, action should be deferred until the August meeting of the new board who will be requested to act on the matter.

AMERICAN INSTITUTE OF MINING AND METALURGICL ENGINEERS

At the meeting of June 25, the American Institute of Metallurgical Engineers discussed the report of delegates to the organizing conference held in Washington, D. C. June 3-4 and gave favorable consideration to joining the Federated American Engineering Societies and referred to subject to the Finance Committee to report on means for meeting the requirements.

AMERICAN SOCIETY OF CIVIL ENGINEERS

The deegates of the American Society of Civil Engineers to the organizing conference of the Federated American Engineering Socities, will be presented at the annual convention Portland, Aug. 10-12.

CANADIAN SECTION OF AMERICAN WATER WORKS ASSOCIATION

The Joint Conference Committee has issued a bulletin relating to the character and purposes of the Federated American Engineering Socities, in which it says that:

"The object of this organization shall be to further the public welfare whenever technical knowledge and engineering experience are involved and to consider and act upon matters of common concern to the engineering and allied technical professions.

"The organization is to deal with what are commonly known as welfare or non-technical matters.

It is a federation of societies with whose autonomy and activities it in no way interferes. It does not create a new organization but it will succeed the present Engineering Council and will be more comprehensive as to scope and membership.

"The Federated American Engineering Societies will not in any sense be a competitor of any existing organization."

AMERICAN CONCRETE INSTITUTE

The meeting of July 16th was held at the Engineering Society Building, New York. It was addressed by W. A. Slater of the Bureau of Standards who discussed shear in reinforced concrete beams in the light of recent investigations which may lead to the possibility of new units of special interest to concrete designers.

FEDERATED AMERICAN ENGINEERING SOCIETIES

A Canadian section of the American Water Works Association having about 100 members has been formed and has elected Alexander Milne, chairman; F. H. Pitcher, vice-chairman; and H. G. Hunter, secretary-treasurer.

ENGINEERING SECTION NATIONAL SAFETY COUNCIL

Safety as an aid to production was the dominant note of the summer meeting of the Engineering Section of the National Safety Council, held in Chicago, June 24.

In opening the meeting, C. P. Tolman, chairman of the Section, emphasized three mental conditions which have a vital bearing on the prevention of accidents. The first is the widely prevalent taint of epilepsy which may cause a man to lose consciousness momentarily and put his hand into a place of danger. The second is the curious effect of habit noted by Dr. D. H. Colcord in the Scientific American for June 12: "A man operating the levers of a crane, oiling a lathe in motion, driving an automobile, or crossing a crowded thoroughfare, may at a dangerous moment continue to act as accustomed by habit, thus occupying the nervous machinery with habit-chains which present conscious control." The third is another mental twist, known to all of us, by which the fear of what would happen if a man should jump off a high building, or drive an automobile into a tree, becomes an uncontrollable impulse to do that very thing.

The dinner, at the Hotel La Salle, was held in co-operation with the Western Society of Engineers. The Chicago Safety Council, and the Illinois Manufacturers' Association, and was attended by more than 200 safety men and executives. The general topic was Production, and addresses approaching this much-discussed topic from different standpoints were given by W. G. Nicholas, president American Manganese Steel Company; George A. Hart, manager, Melrose Park Plant, National Malleable Castings Company; and Sidney J. Williams, secretary and chief engineer, National Safety Council.

PERSONALS

Holmes, J. A., has been appointed resident engineer for the construction of an $750,000 earth dam at Decatur, Ill.

Witherspoon, H. K. has been appointed to the position of project engineer of the North Carolina State Highway Commission.

McComb, B. Q. highway engineer of the U. S. Bureau of Public Roads, has resigned that position to accept the appointment of division engineer,

Gadd, R. F. has been made president of the Board of Water Commissioners of Hartford, Conn.

Haase, H. J., has been made water commissioner of Elmira, New York.

Emprie, John has been appointed resident engineer of construction on the provincial highway, Canada.

Loder, A. E., has been appointed district engineer for the U. S. Bureau of Public Works in charge of South Carolina, Georgia, Florida, Alabama, Mississippi and Tennessee with headquarters at Washington, D. C.

Neuschwander, E. P., has been appointed assistant engineer of the New York Bridge and Tunnel Commission.

Potter, Prof. A. A., has been appointed dean of engineering at Purdue University.

Russell, G. A., has been appointed engineer of Geary County, Kans.

Keith, Clark, has been appointed assistant chief engineer of the Essex Border Utilities Commission, with jurisdiction of water supply, sewerage, and park systems of several municipalities near the Detroit River.

Wilkerson, T. J., will open a consulting engineering office for steel and concrete construction at Beaver Falls, Pa.

Perring, H. G., has been apointed to a position on the city engineers staff, Baltimore.

McCarty, Joseph, has organized the Joseph McCarty Construction Company of Kaukauna, Wis., for paving and reinforced concrete work.

Ames, G. K., has opened an engineering office at Tallahassee, Florida.

Polk, M. C., has opened an engineering office in Butte County, Calif.

Bellows, O. F., has been appointed assistant engineer of the N. Y. & N. J. Bridge & Tunnel Commission.

Royall, R. E., has been appointed associate professor of highway engineering in Washington and Lee University.

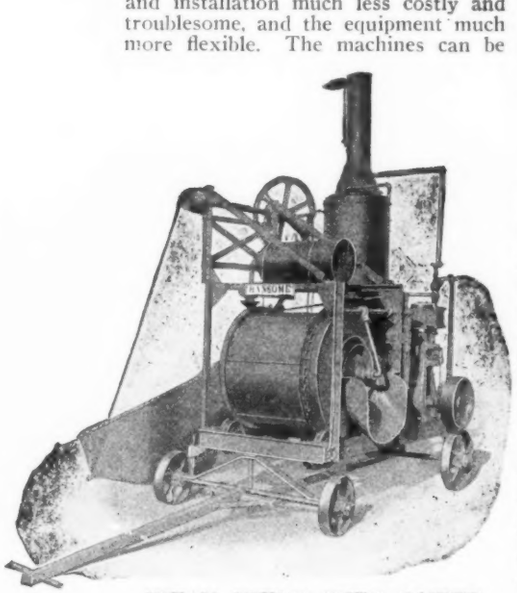
Chapman, H. D., has been appointed city engineer and superintendent of streets, Richmond, Calif.

New Appliances

Describing New Machinery, Apparatus, Materials and Methods and Recent Interesting Installations

IMPROVED BANTAM MIXER

The use of a single large concrete mixer on a job involves high first cost, expensive transportation and installation, large driving power, costly repairs and total interruption of work when disabled. For several years the policy has been gaining ground, of substituting two or more smaller machines for one large machine. The aggregate first cost may be little or no larger than that of the single machine, the weight is less, transportation and installation much less costly and troublesome, and the equipment much more flexible. The machines can be



STEAM MIXER WITH POWER LOADER AND WATER TANK

distributed at different parts of a large piece of work and greatly facilitate the rapid placing of the concrete, one or more may be out of commission without totally stopping the work, the number used may be proportioned to the amount of product rquired at any given time, and they are particularly adapted to conditions where the concrete is required in small or separated units.

These considerations and the desire to make the best and most satisfactory tool for universal operations have governed the design of the Bantam concrete mixer, manufactured by the Ransome Concrete Machinery Company.

The mixers are made in two sizes with capacities of 7 to 10 cubic feet mixed concrete per batch. The mixer, water tank and engine enclosed in a structural steel frame provided with light steel panels to completely protect it, mounted on a steel truck, weigh from 2,800 pounds to 5,150 pounds, according to size and type of engine. They are equipped with a power loader and with steam or gasoline engine as preferred, and combine rapid, thorough mixing with fast discharge for any product, no matter how dry. This is particularly advantageous for curb and gutter work, where the forms are usually stripped as quickly as possible. They are claimed to be excellent mortar mixers, for which purpose they are frequently exclusively used.

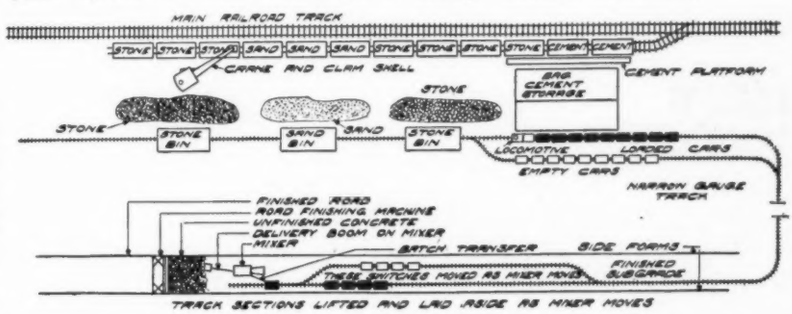
The large size, driven by a 4 h. p. engine developing at least 25 per cent excess power, is provided with a builder's hoist which has a capacity of 750 pounds on a single line at 125 feet per minute. Special attention given to improvements in the chains, rollers and door hanger hub, are claimed to eliminate about all of the troubles that can be foreseen for a machine of this class.

LAKEWOOD CONSTRUCTION PLANT

Bulletin No. 29-B of the Lakewood Engineering Company is prepared with the idea of service to road contractors and thus is of more interest and value than a mere catalog or specifications of the up-to-date plant and the equipment that it enumerates, including concrete paving machines, steam engines, portable pumping plants, locomotive unloading cranes, portable concrete mixers and a variety of standard cars, track and other standard plant.

Among the special equipment is the Lakewood concrete road finisher, a machine that spreads, tamps, and belt-finishes the road surface by power with rapidity, economy and efficiency. There is also a batch transfer attachment for the mixing machine that consists virtually of a small tilting boom derrick mounted alongside the machine on two extra wheels and operated without extra power by the weight of the descending skip so as to dump complete batches of aggregate quickly and easily into the charging skip.

The bulletin devotes several pages to the discussion and illustration of methods, plant and equipment for storing, transporting, handling and charging aggregate, cement and concrete for road construction. These are illustrated by photographs showing the charging of the concrete mixer and by diagrams giving two separate plant layouts one of which shows a single road concreting plant served by a single-track service line laid on subgrade, while the other shows two concreting plants moving in the same direction and served by rolling stock operated on a single-track line extended in both directions from the storage pile alongside the alignment of the concrete road and shifted to keep pace with the advance of the machines on the latter.



UNLOADING, STORING, RELOADING AND DISTRIBUTING CONCRETE ROAD MATERIALS WITH TRAINS OF BATCH-BOX CARS

IRRIGATION SUPPLIES

The new catalog No. 11 of the R. Hardesty Manufacturing Company has descriptions, illustrations and diagrams of supplies, equipment, and plant for irrigation purposes. It is printed on 123 pages of heavy calendered paper and includes various useful formulas and tables such as the velocity of flow of water, capacity of flumes, safe loads on wooden columns and beams, the flow of water through pipes and orificies and construction blueprints, making it somewhat resemble a hand book as well as a descriptive catalog. One inset gives Kutters formula with an example and with a graphical diagram for the complete solution of the formula by inspection.

The principal items listed include automatic irrigation dams, flumes and their accessories, gates, pipes, pipe fittings, valves, radial gates, gate hoists, shear gates, hand pull lateral gates, screw lift gates, diversion gates, flume inlets and cut-off aprons and other articles. The same company issues special catalog No. 10 and catalogs of corrugated culverts, flumes, street and highway signs.

SEWER GATES

Various types of gate valves, lateral gates, canal and reservoir gates, high presure reservoir gates, diversion gates, hand wheels and stems for gates, pedestal gate lifts, loose gates, metal flumes, and the light metal measuring devices and adjustable irrigation dams primarily designed for irrigation supplies, supplied by the R. Hardesty Manufacturing Company, include a number of items conveniently available for service in sewers and sewage disposal operations.

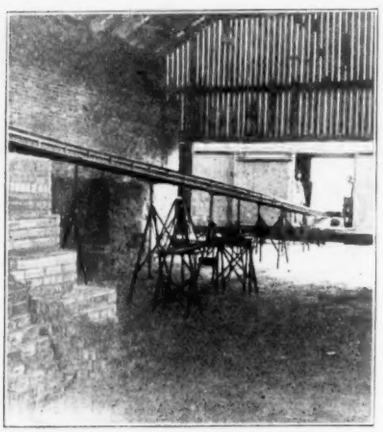
STANDARD GRAVITY ROLLER CONVEYORS

As the name implies, the equipment put on the market by the Standard Conveyor Company provides for the transfer of a large range of building and construction materials by the force of gravity without involving the development or application of mechanical power. It is only necessary to provide a slightly inclined pathway between the terminals and the materials or articles practically transport themselves rapidly, continuously and safely requiring only to be loaded and unloaded from the transporter.

TRANSPORTING BRICKS ON GRAVITY ROLLER CONVEYOR

The transporter consists simply of a continuous system of easily operated horizontal hollow transverse rollers in a plane inclined about 1:24, and on a straight or curved alignment. The rollers are light and rigid with anti-friction ball bearings and are made up in standard units with light frameworks 10 feet long adjustably supported on portable stable angle-iron trestles that provide a great degree of flexibility. They are made in different weights and sizes to suit different requirements. They are very easily installed and shifted and require little or no maintenance, repairs and attention. They are particularly useful for loading and unloading cars and trucks and for delivering materials.

For handling bricks, the latter may be placed on them in groups supported directly on the rollers or they may be set on pallets facilitating their rapid removal in definite quantities. Pallets are also useful for handling stacks of cement to and from the storehouse or to the concrete mixer and may be conveniently connected by short light chains to facilitate their return. For handling tiles, concave cast rollers fitting the tile section are recommended. Lumber, steel rods, reinforcing bars, and many other supplies and materials can be handled by the gravity system, effecting great saving of labor and time.

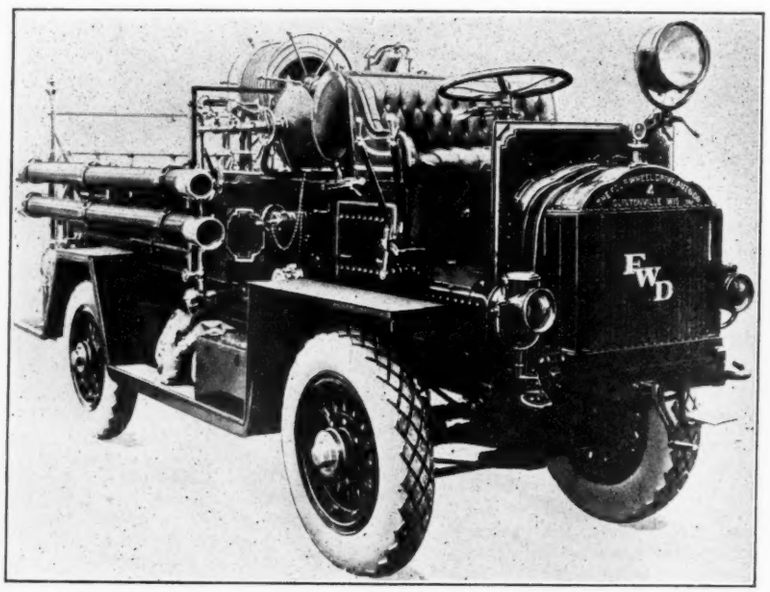


GRAVITY ROLLER CONVEYOR SYSTEM WITH ADJUSTABLE TALL SUPPORTS

NEW AUTOMOBILE FIRE TRUCK

Announcement is made of the development of a new 3-ton fire truck by the Four Wheel Drive Auto Company, makers of FWD trucks. It has an unusually powerful special type J. Wisconsin motor, with a five and one-tenth inch bore and a five and one-half inch stroke, developing 42 h.p. S.A.E. The type B rotary pump, driven through a two-speed transmission, has a capacity of 500 gallons at 120 pounds pressure.

Complete modern fire-fighting equipment is mounted on the body, which is 9 feet long, 4 feet wide and 22 inches deep. A speed of twenty-five miles per hour can be attained.



THREE-TON FIRE TRUCK EQUIP PED WITH 500-GALLON ROTARY PUMP

INDUSTRIAL NOTES

HERBERT POST GREEN AND ASSOCIATES, INC.

Herbert Post Green, E. B. Black, John C. Prior, Austin W. Lord, and W. S. Manning, have opened an architectural and engineering office in New York with branch offices in Kansas City, Missouri and Columbus, Ohio.

Besides ordinary design and construction services the firm will offer special services to architects, engineers owners and contractors and will act as arbitrers between them.

TECHNICAL ADVISORY CORPORATION

Technical Advisory Corporation, with offices at 132 Nassau Street, New York City, has recently been organized to act as consulting engineers and industrial economists and advisers. The officers of the new organization are: President, Campbell Scott; vice-president and treasurer, Ernest P. Goodrich, and vice-president and secretary, William D. Ennis.

BLAW-KNOX PERSONNEL

Dewitt Clinton Grove, past vice-president of the Technical Publicity Association, has become advertising manager of the Blaw-Knox Co., of Pittsburgh, manufacturers of Blaw Buckets, Blawforms for concrete construction, Prudential Steel Buildings, Knox Water-Cooled Doors and ports, Transmission Towers, and structural and plate steel products. Mr. Grove succeeds George Land, who resigned July 1st, to enter the agency field as head of the Technical Publicity Co., of Pittsburgh.

Mr. Grove came to the Blaw-Knox Company from the H. S. Cameron Pump Co., a subsidiary of the Ingersoll-Rand Co., where he was in charge of the advertising department. Previous to that, he handled the advertising of mining machinery and other equipment for the Ingersoll-Rand Co. For eight years before this he was advertising manager of the Deihl Manufacturing Co., of Elizabethport. He was chairman of the executive committee of the Elizabeth Advertising Club.

Another new man in the Blaw-Knox advertising department is Leo Robin, a former newspaper editor of Pittsburgh, who in connection with other duties is editing "Blaw-Knox Life," the company's house organ.